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PROCEEDINGS

OF THE
THIRD ANNUAL ACQUISITION
RESEARCH SYMPOSIUM

Acquisition Research: Creating Synergy for Informed Change

May 17-18, 2006

Published: 30 April 2006

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Prepared for: Naval Postgraduate School, Monterey, California 93943



ACQUISITION RESEARCH
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
NAVAL POSTGRADUATE SCHOOL

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Preface and Acknowledgements

Those familiar with the Naval Postgraduate School's Acquisition Research Program know that, since its inception in 2003, we have promoted the idea of "big A Acquisition" as a core theme. This term is intended to highlight Acquisition's inherent complexity as an endeavor that entails a variety of challenges, including political, managerial, technological and—in the case of defense Acquisition—military challenges. It also highlights the need for research from a variety of disciplines to be brought to bear in order to meet these challenges.

The NPS Acquisition Research Program's purposeful pursuit of "big A Acquisition" research is evident in these Proceedings. Disciplines and fields of study which are represented include contract management, project management, logistics and supply chain management, systems engineering, economics, public management and policy, financial management, information systems, and organizational behavior. While research in a few other disciplines (e.g., personnel management) has yet to be tapped, the engagement of such a wide range of approaches represents, in our view, significant progress.

The past year marked "the coming of age" of the Acquisition Research Program. By every measure, the program grew and matured. The number of projects and products more than doubled over 2004 and faculty participation was up 50%. Of special significance was the increased involvement of tenured track faculty, from eight to twenty-one, in acquisition research. Much of this progress can be attributed to the increased stability of the program. Funds were readily identifiable and available to allow faculty to count on them when formulating their work plans for the coming year. A formalized research proposal and solicitation process was established by the Associate Dean of Research in the Graduate School of Business and Public Policy (GSBPP) which greatly enhanced communication about the program and encouraged participation. It was apparent that interest in the program had spread throughout the faculty, and future program growth would be constrained only by financial resources. Similar remarks could be made about student involvement and participation.

The program has also made a major contribution to maintaining the relevancy of faculty and instructional materials. Significant benefits to researchers include: (1) provision of funding which saves researchers "marketing" time; (2) ties with sponsor POCs, thus assuring DoD-relevant research; (3) assistance with final formatting, editing and publishing, thus relieving researchers from the "non-intellectual" aspects of their research. Each of these is a substantial benefit, but the growing connectivity between researchers and sponsors is paying large dividends to all concerned. New, relevant instructional materials emerge out of almost all research products, and this has a positive impact on all students. Sponsors receive substantial help and insight with the business issues of the day. Faculty are "refreshed" in DoD-relevant subject matter, and students are better prepared to enter the acquisition work force.

In summary, through the combined efforts of our sponsors, research partners, faculty, students and the Acquisition Chair, the NPS Acquisition Research Program has made excellent progress toward achieving its stated goals:



- 1. Position NPS as a recognized leader in defense acquisition research.**
- 2. Establish NPS acquisition research as an integral part of policy-making for Department of Defense officials.**
- 3. Create a stream of relevant information concerning the performance of DoD Acquisition policies with viable recommendations for continuous process improvement.**
- 4. Prepare the DoD workforce to participate in the continued evolution of the defense acquisition process.**
- 5. Collaborate with other universities, think tanks, industry and government in acquisition research.**

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the Acquisition Research Program:

- Under Secretary of Defense (Acquisition, Technology and Logistics)
- Assistant Secretary of the Navy (Research, Development and Acquisition)
- Commander, Naval Sea Systems Command
- Program Executive Officer (Ships)
- Program Executive Officer (Integrated Warfare Systems)
- Program Executive Officer (Littoral and Mine Warfare)
- Dean of Research, Naval Postgraduate School

We also thank UGS Corporation and the Naval Postgraduate School Foundation and acknowledge their generous contributions in support of this symposium.

James B. Greene, Jr.
Rear Admiral, US Navy (ret)

Keith F. Snider, PhD
Associate Professor



The NPS A Team

Rear Admiral James B. Greene, Jr. USN (Ret.) — Acquisition Chair, Naval Postgraduate School. RADM Greene develops, implements and oversees the Acquisition Research Program in the Graduate School of Business and Public Policy. He interfaces with the DoD, industry and government leaders in acquisition, supervises student MBA projects and conducts guest lectures and seminars. Before serving at NPS, RADM Greene was an independent consultant focusing on Defense Industry business development strategy and execution (for both the public and private sectors), minimizing lifecycle costs through technology applications, alternative financing arrangements for capital-asset procurement, and “red-teaming” corporate proposals for major government procurements.

RADM Greene served as the Assistant Deputy Chief of Naval Operations (Logistics) in the Pentagon from 1991-1995. As Assistant Deputy, he provided oversight, direction and budget development for worldwide US Navy logistics operations. He facilitated depot maintenance, supply-chain management, base/station management, environmental programs and logistic advice and support to the Chief of Naval Operations. Some of his focuses during this time were leading Navy-wide efforts to digitize all technical data (and, therefore, reduce cycle time) and to develop and implement strategy for procurement of eleven Sealift ships for the rapid deployment forces. He also served as the Senior Military Assistant to the Under Secretary of Defense (Acquisition) from 1987-1990 where he advised and counseled the Under Secretary in directing the DoD procurement process.

From 1984-1987, RADM Greene was the Project Manager for the Aegis project. This was the DoD's largest acquisition project with an annual budget in excess of \$5 Billion/year. The project provided oversight and management of research, development, design, production, fleet introduction and full lifecycle support of the entire fleet of Aegis cruisers, destroyers and weapons systems through more than 2500 industry contracts. From 1980-1984, RADM Greene served as Director, Committee Liaison, Office of Legislative Affairs followed by a tour as the Executive Assistant, to the Assistant Secretary of the Navy (Shipbuilding and Logistics). From 1964-1980, RADM Greene served as a Surface Warfare Officer in various duties, culminating in Command-at-Sea. His assignments included numerous wartime deployments to Vietnam as well as the Indian Ocean and the Persian Gulf.

RADM Greene received a BS in Electrical Engineering from Brown University in 1964; he earned an MS in Electrical Engineering and an MS in Business Administration from the Naval Postgraduate School in 1973.

Keith F. Snider — Associate Professor of Public Administration and Management in the Graduate School of Business & Public Policy at the Naval Postgraduate School in Monterey, California, where he teaches courses related to defense acquisition management. He also serves as Principal Investigator for the NPS Acquisition Research Program and as Academic Associate for resident NPS acquisition curricula.

Professor Snider has a Ph.D. in Public Administration and Public Affairs from Virginia Polytechnic Institute and State University, a Master of Science degree in Operations Research from the Naval Postgraduate School, and a Bachelor of Science degree from the United States Military Academy at West Point. He served as a field artillery officer in the U.S. Army for twenty years, retiring at the rank of Lieutenant Colonel. He is a former



member of the Army Acquisition Corps and a graduate of the Program Manager's Course at the Defense Systems Management College.

Professor Snider's recent publications appear in *American Review of Public Administration*, *Administration and Society*, *Administrative Theory & Praxis*, *Journal of Public Procurement*, *Acquisition Review Quarterly*, and *Project Management Journal*.

Karey L. Shaffer — Program Manager for the Acquisition Research Program at the Graduate School of Business and Public Policy, Naval Postgraduate School. As PM, Shaffer is responsible for operations and publications in conjunction with the Acquisition Chair and the Principal Investigator. She has also catalyzed, organized and managed the Acquisition Research Symposiums hosted by NPS.

Shaffer has also served as an independent Project Manager and Marketing Consultant on various projects. Her experiences as such were focused on creating marketing materials, initiating web development, assembling technical teams, managing project lifecycles, processes and cost-savings strategies.

From 2001-2002, Shaffer contracted to work as the Executive Assistant to the Vice President for Leadership and Development Human Resources for Metris Companies in Minneapolis. In this capacity, she introduced project lifecycle and process improvements to increase efficiency. Likewise, as a Resource Specialist contractor at Watson Wyatt Worldwide in Minneapolis, she developed and implemented template plans to address continuity and functionality in corporate documents; in this same position, she introduced process improvements to increase efficiency in presentation and proposal production in order to reduce the instances of corruption and loss of vital technical information.

Shaffer has also served as the Project Manager for Imagicast, Inc. and as the Operations Manager for the Montana World Trade Center. At Imagicast, she was asked to take over the project management of four failing pilots for Levi Strauss in the San Francisco office. Within four months, the pilots were released; the project lifecycle was shortened; and the production process was refined. In this latter capacity at the MWTC, Shaffer developed operating procedures, policies and processes in compliance with state and federal grant law. Concurrently, she managed \$1.25 million in federal appropriations, developed budgeting systems and secured a \$400,000 federal technology grant. As the Operations Manager, she also designed MWTC's Conference site, managed various marketing conferences, and taught student practicum programs and seminars.

Shaffer has her BA in Business Administration (focus on International Business, Marketing and Management) from the University of Montana. She is currently earning her MBA from San Francisco State University.

A special thanks to our editor Jeri Larsen for all that she has done to make this publication a success, to David Wood, Lea Houlette and Ian White for production and graphic support, to Lindsay D'Penha for CD programming and to the staff at the Graduate School of Business & Public Policy for their administrative support. Our program success is directly related to the combined efforts of many.



4th Annual Acquisition Research Symposium Announcement and Call for Proposals

The Graduate School of Business & Public Policy at the Naval Postgraduate School announces the **4th Annual Acquisition Research Symposium** to be held **May 16-17, 2007 in Monterey, CA.**

This symposium serves as a forum for the presentation of acquisition research and the exchange of ideas among scholars and practitioners of public-sector acquisition. We seek a diverse audience of influential attendees from academe, government, and industry who are well placed to shape and promote future research in acquisition.

The Symposium Program Committee solicits proposals for panels and/or papers from academicians, practitioners, students and others with interests in the study of acquisition. The following list of topics is provided to indicate the range of potential research areas of interest for this symposium: **acquisition and procurement policy, supply chain management, public budgeting and finance, cost management, project management, logistics management, engineering management, outsourcing, performance measurement.**

Proposals must be submitted by **November 17, 2006**. The Program Committee will make notifications of accepted proposals by **December 15, 2006**. Final papers must be submitted by **April 6, 2007** in order to be included in the Symposium Proceedings.

Proposals for papers should include an abstract along with identification, affiliation, and contact information for the author(s). Proposals for panels (plan for 90 minute duration) should describe the panel subject and format, along with participants' names, qualifications and the specific contributions each participant will make to the panel.

Send proposals via e-mail to Karey Shaffer klshaffe@nps.edu .

Symposium details (hotel, registration, etc.) will be posted at www.researchsymposium.org.



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Keynote Speaker

Wednesday, May 17, 2006	Keynote Speaker
8:00 a.m. – 9:15 a.m.	Keynote Speaker The Honorable Kenneth J. Krieg , Under Secretary of Defense (Acquisition, Technology and Logistics)

Keynote Speaker – The Honorable Kenneth J. Krieg, Under Secretary of Defense (Acquisition, Technology and Logistics)

As the Under Secretary of Defense (AT&L), Mr. Krieg is responsible for advising the Secretary and Deputy Secretary of Defense on all matters relating to the DoD Acquisition System, research and development, advanced technology, developmental test and evaluation, production, logistics, installation management, military construction, procurement, environmental security, nuclear, chemical, and biological matters; as well as logistics policy matters to assist the end-to-end logistics process in delivering to the warfighter.

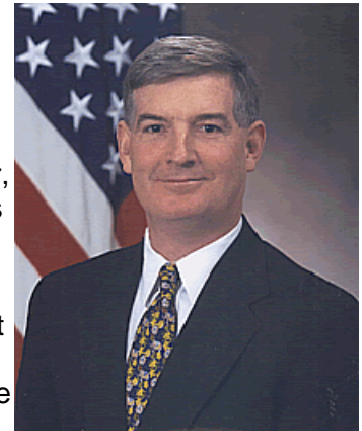
Before his appointment to USD (AT&L), Mr. Krieg served at the Department of Defense as Special Assistant to the Secretary and Director for Program Analysis & Evaluation. In this capacity, he led an organization that provides independent advice to the Secretary of Defense in a range of areas including defense systems, programs and investment alternatives as well as providing analytic support to planning and resource allocation.

He joined the Department of Defense in July 2001 to serve as the Executive Secretary of the Senior Executive Council (SEC). The SEC, comprised of the Secretary, Deputy Secretary, Service Secretaries and Under Secretary (AT&L), is responsible for leading initiatives to improve the management and organization of the Department of Defense.

Prior to joining the Department of Defense, Mr. Krieg worked for International Paper, most recently as Vice President and General Manager of the Office and Consumer Papers Division. He had responsibility for the company's \$1.4 billion retail, commercial office, and consumer papers businesses. During his 11 years with the Stamford, CT-based company, Mr. Krieg held marketing and sales positions and was actively involved in the merger of three major paper companies into International Paper.

Before moving to industry, Mr. Krieg worked in a number of defense and foreign policy assignments in Washington, DC, including positions at the White House, on the National Security Council Staff, and in Office of the Secretary of Defense.

Mr. Krieg received his BA degree in history from Davidson College and his Masters in Public Policy from the Kennedy School of Government at Harvard University.



Plenary Panel - Acquisition Reform

Wednesday, May 17, 2006	Plenary Panel – Acquisition Reform
9:15 a.m. – 10:45 a.m.	<p>Chair:</p> <p>Jacques Gansler – former Under Secretary of Defense (Acquisition, Technology and Logistics); presently Vice President for Research; also Professor and Roger C. Lipitz Chair and Director, Center for Public Policy and Private Enterprise at the University of Maryland</p> <p>Discussants:</p> <p>Lieutenant General Joseph L. Yakovac, Jr., US Army – Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics & Technology</p> <p>Rear Admiral Charles S. Hamilton II, US Navy – Program Executive Officer Ships</p> <p>Nancy Spruill – Director, Acquisition Resources & Analysis, Office of the Under Secretary of Defense (Acquisition Reform)</p>

Chair: Jacques Gansler – former Under Secretary of Defense (Acquisition, Technology and Logistics); presently Vice President for Research; also Professor and Roger C. Lipitz Chair and Director, Center for Public Policy and Private Enterprise at the University of Maryland

Dr. Gansler, former Under Secretary of Defense for Acquisition, Technology and Logistics, is the first holder of the Roger C. Lipitz Chair in Public Policy and Private Enterprise. As the third ranking civilian at the Pentagon from 1997 to 2001, Professor Gansler was responsible for all research and development, acquisition reform, logistics, advanced technology, environmental security, defense industry, and numerous other security programs. Before joining the Clinton Administration, Dr. Gansler held a variety of positions in government and the private sector, including Deputy Assistant Secretary of Defense (Material Acquisition), Assistant Director of Defense Research and Engineering (Electronics), Vice President of ITT, and engineering and management positions with Singer and Raytheon Corporations. Throughout his career, Dr. Gansler has written, published and taught on subjects related to his work. He is the author of *Defense Conversion: Transforming the Arsenal of Democracy*, MIT Press, 1995; *Affording Defense*, MIT Press, 1989, and *The Defense Industry*, MIT Press, 1980. He has published numerous articles in *Foreign Affairs*, *Harvard Business Review*, *International Security*, *Public Affairs*, and other journals as well as newspapers and frequent Congressional testimonies. He is a member of the National Academy of Engineering and a Fellow of the National Academy of Public Administration.



Discussant: Lieutenant General Joseph L. Yakovac, Jr., US Army – Military Deputy to the Assistant Secretary of the Army for Acquisition, Logistics & Technology

Commissioned in the Infantry upon graduation from the United States Military Academy, Lieutenant General Yakovac has served in a variety of command and staff positions at company grade through general officer ranks. He was a Platoon Leader, Executive Officer and Company Commander in mechanized infantry units. Following these assignments, Lieutenant General Yakovac earned a Master of Science degree in Mechanical Engineering from the University of Colorado. He subsequently served as an Assistant Professor at the United States Military Academy.



Lieutenant General Yakovac's field grade assignments include Executive Officer and Branch Chief, Bradley Project Office; Brigade Logistics Officer, Brigade Operations Officer, and Battalion Executive Officer, US Army Europe; Staff Officer, Armor/Anti-Armor Task Force, Office of the Chief of Staff, Army; Mechanized Infantry Battalion Commander; Director, Weapons Systems Management Directorate, US Army Tank-automotive and Armaments Command; and Project Manager, Bradley Fighting Vehicle System.

Prior to Lieutenant General Yakovac's position as the MILDEP, which he assumed in November 03, he served most recently as the Program Executive Officer, Ground Combat and Support Systems, now known as Ground Combat Systems, and as Deputy for Systems Acquisition, US Army Tank-automotive and Armaments Command (TACOM). Before going to TACOM, his last position in the Pentagon was the Assistant Deputy for Systems Management and Horizontal Technology Integration, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology).

Lieutenant General Yakovac is a graduate of the Armor Officer Advanced Course, the Army Command and General Staff College, the Defense Systems Management College and the Industrial College of the Armed Forces. He wears the Expert Infantry Badge, the Ranger Tab, the Parachutist Badge as well as the Distinguished Service Medal, three Legions of Merit and seven awards of the Army Meritorious Service Medal.

Discussant: Rear Admiral Charles S. Hamilton II, US Navy – Program Executive Officer Ships

Rear Admiral Hamilton is a native of Amityville, N.Y. He attended Duke University, graduating in May 1974 with a Bachelor of Science in Zoology. He was commissioned in the Navy in May 1974 through the NROTC Program at Duke. Rear Adm. Hamilton's sea tours include USS Hawkins (DD 873); USS Coontz (DDG 40); USS Callaghan (DDG 994); USS Fox (CG 33); and command of USS O'Brien (DD 975).



Rear Adm. Hamilton's shore tours include Program Resource Appraisal Division (OP-91), Office of the Chief of Naval Operations; Aegis Cruiser Destroyer Branch, Office of the Chief of Naval Operations (OP 355F); and Military Staff Specialist for Naval Warfare in the Office of the Under Secretary of Defense (Acquisition and Technology).



In May 1996, Rear Adm. Hamilton became Program Manager for the Arsenal Ship, which was designed to provide massed precision fires in support of Fleet Commander's warfighting requirements. From April 1998 to February 2000, Rear Adm. Hamilton served as Deputy for Fleet in the Program Executive Office Theater Surface Combatants (PEO TSC-F).

Rear Adm. Hamilton served as Program Executive Officer for Surface Strike (PEO (S)) from February 2000 until November 2002. Following consolidation of the PEO structure in November 2002, Rear Adm. Hamilton became Deputy PEO for Ships.

In April 2003 Rear Adm. Hamilton was named Program Executive Officer for Ships. PEO Ships provides the Navy with a single, platform-focused organization responsible for the research, development, systems integration, construction, and lifecycle support of current and future surface combatant, amphibious and auxiliary ships to include: DD 963, FFG 7, DDG 51, CG 47, DD(X), LCS, MCM, MHC, LPD 17, LHD, LHA(R), MPF(F), Sealift Ships, CLF Ships, Special Mission Ships, Coast Guard Deepwater Support, Small Boats and Craft, Command Ships, and MSC vessels.

Rear Adm. Hamilton's graduate education includes Naval Postgraduate School, Monterey, Calif., where he graduated with distinction, receiving a Master of Arts in National Security Affairs, and the National War College where he graduated with distinction and was awarded a Master of Science in National Security Strategy.

Rear Adm. Hamilton's awards include the Defense Superior Service Medal (oak leaf cluster in lieu of second award), Legion of Merit (gold star in lieu of second award), Meritorious Service Medal (with three gold stars), Navy Commendation Medal and various unit and service awards.

Discussant: Nancy Spruill – Director, Acquisition Resources & Analysis, Office of the Under Secretary of Defense (Acquisition Reform)

Dr. Nancy Spruill received Bachelor of Science degree in Mathematics, in 1971. From 1971 to 1983, she held a variety of positions with the Center for Naval Analyses, including Technical Staff Analyst, Professional Staff Analyst and Project Director. She earned her Master of Arts in Mathematical Statistics in 1975 followed by her Doctorate in 1980.

Dr. Spruill served on the staff of the Office of the Secretary of Defense from 1983 to 1993. Initially, she was the Senior Planning, Programming, and Budget Analyst in the Manpower, Reserve Affairs and Logistics Secretariat. Later, she served as the Director for Support and Liaison for the Assistant Secretary of Defense for Force Management and Personnel. Then she served as the Senior Operations Research Analyst in the Office of the Assistant Secretary of Defense for Program Analysis and Evaluation.

In 1993, she joined the staff of the Defense Mapping Agency (DMA), serving as the Chief of Programs and Analysis Division for the DMA Comptroller. Her role included oversight of the Agency's \$800M program. Subsequently, she served as Acting Deputy Comptroller and was a member of the Reinvention Task Force for the Vice President's National Performance Review. Her reengineering work was implemented and resulted in a mapping organization that is customer focused and reduced in the management layers from eleven to three.



In March 1995, she was selected as the Deputy Director for Acquisition Resources for the Under Secretary of Defense for Acquisition and Technology (USD (AT&L)). In February 1999, she was appointed Director, Acquisition Resources & Analysis (ARA) for USD (AT&L). In this capacity she is responsible for the coordination of all defense acquisition and technology planning, programming, and budgeting process activities, as well as funds control, Congressional actions in the authorization and appropriations processes, and special analyses for the Under Secretary. She also manages the studies program for OSD and oversees USD (AT&L)'s office automation system and manages its information system network.

Dr. Spruill has been a member of the Senior Executive Service since 1995. She is a certified Acquisition Professional and an active member of the American Statistical Association. Her many honors and awards include the Defense Medal for Exceptional Civilian Service, the Defense Medal for Meritorious Civilian Service, and the Hammer Award. She has contributed papers in publications of the statistics and defense analyses communities and authored articles in the general press on how politicians use - and abuse - statistics.



Panel – Enhancing Collaborative Capacity in Acquisition Organizations

Wednesday, May 17, 2006	Enhancing Collaborative Capacity in Acquisition Organizations
11:00 a.m. – 12:30 p.m.	<p>Chair:</p> <p>Lorna Estep – Deputy Director for Supply, Directorate of Logistics and Sustainment, Headquarters Air Force Materiel Command</p> <p>Discussant:</p> <p>Michael Schwind – UGS Corporation</p> <p>Papers:</p> <p><i>Collaborative IT Tools Leveraging Competence: Antecedents and Consequences</i></p> <p>Paul Pavlou, University of California</p> <p>Angelica Dimoka, University of Southern California</p> <p>Tom Housel, Naval Postgraduate School</p> <p><i>Building Collaborative Capacity in the Interagency Context</i></p> <p>Gail Fann Thomas, Naval Postgraduate School</p> <p>Erik Jansen, Naval Postgraduate School</p> <p>Susan Page Hocevar, Naval Postgraduate School</p>

Chair: Lorna Estep – Deputy Director for Supply, Directorate of Logistics and Sustainment, Headquarters Air Force Materiel Command

Ms. Estep, a member of the Senior Executive Service, is Deputy Director for Supply, Directorate of Logistics and Sustainment, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. She is responsible for the Materiel Support Division of the Supply Management Activity Group, a stock fund with annual sales of \$7 billion. She directs a wide range of logistics services in support of Air Force-managed spare parts, to include transformation programs, requirements determination, budgeting, acquisition, provisioning, cataloging, distribution and data management policy. She also provides supply chain management policy, guidance and direction in support of headquarters, air logistics centers, and US Air Force worldwide customers.



Ms. Estep started her career as a Navy logistics management intern. She has directed the Joint Center for Flexible Computer Integrated Manufacturing, was the first



program manager for Rapid Acquisition of Manufactured Parts, and has served as Technical Director of Information Technology Initiatives at the Naval Supply Systems Command. In these positions she has developed logistics programs for the Department of Defense, implemented one of the first integrated and agile data-driven manufacturing systems, and directed the development of complex technical data systems for the Navy.

As the Director of Joint Logistics Systems Center, Ms. Estep had the duties of a commanding officer for a major subordinate command. In addition, she acted as the Logistics Community Manager, an emerging organization to coordinate and implement the revised Defense Department logistics strategy for achieving Joint Vision 2010 through modern information techniques and processes. She has also served as Chief Information Officer for the Naval Sea Systems Command in Arlington, Va, and Executive Director of Headquarters Materiel Systems Group at Wright-Patterson AFB. Prior to her current assignment, she served as Deputy Director for Logistics Readiness at the Pentagon, where she developed combat support concepts, doctrine, and sustainment policy with the Office of the Secretary of Defense, defense agencies, the Joint Chiefs of Staff and combatant commanders.



Collaborative IT Tools Leveraging Competence: Antecedents and Consequences

Presenter: Paul Pavlou, University of California

Angelika Dimoka, University of Southern California

Tom Housel, Naval Postgraduate School

Abstract

A fundamental problem for IS academics and managers is how collaborative IT tools can be properly used to create business value. To shed light on this problem, this paper introduces the notion of “Collaborative IT Tools Leveraging Competence” as the ability of groups to effectively leverage the IT functionalities of collaborative IT tools to facilitate their group activities. Collaborative IT Tools Leveraging Competence is conceptualized as a formative second-order construct formed by the group’s effective use of the following six key IT functionalities: workspace sharing, conferencing, file sharing, scheduling, chat, and email. Collaborative IT Tools Leveraging Competence is hypothesized to facilitate group performance (process efficiency, project effectiveness, and situational awareness), particularly in intense work environments. To enhance a group’s ability to effectively leverage collaborative IT tools, the study proposes a set of enabling factors: customization of the collaborative IT tools, the group’s habit in using collaborative IT tools, the group’s perceived usefulness and ease of use of collaborative IT tools, the group member’s mutual trust, and the degree of environmental intensity.

Data from 365 group managers support the proposed structural model with the antecedents and consequences of Collaborative IT Tools Leveraging Competence at different levels of environmental intensity. The paper discusses the study’s contributions of better understanding the nature, antecedents, and consequences of Collaborative IT Tools Leveraging Competence. Implications for evaluating and enhancing the role of collaborative IT tools are discussed.

Keywords: Collaborative Tools, IT Leveraging Competence, Group Performance, Customization

Introduction

Collaborative IT tools, such as Groove and Oracle Collaboration Suite are integrated sets of IT functionalities that enable communication and information sharing among inter-connected entities. By enabling collaboration in places where it was not feasible before and improving existing collaborative work among groups, collaborative IT tools have transformed the established nature of traditional collaborative group work, and they have thus sparked increased interest among academics and practitioners (e.g., Easley, Devaraj, & Crant, 2003). However, despite the widely publicized potential of collaborative IT tools to improve group work, we still know little whether, how, and why these IT tools can enhance group performance.

To shed light on this question, this study follows the proposed focus of Pavlou and El Sawy (2006) on the *leveraging* dimension of IT capability to introduce the notion of



“Collaborative IT Tools Leveraging Competence,” which is defined as the ability of groups to effectively leverage the IT functionalities of collaborative IT tools to facilitate their group activities. Since collaborative IT tools can be viewed as generic information technologies whose IT functionalities cannot be differentiated across groups, the proposed focus brings forth the strategic potential of groups to differentiate from other groups on the basis of how well they leverage generic IT functionalities. Moreover, since collaborative IT tools are primarily used by groups to facilitate their group activities, the proposed construct is conceptualized at the process-level of analysis, following Ray, Muhanna, and Barney (2005) who argue that the process (not the firm) level of analysis is the most appropriate level for observing the business value of IT.

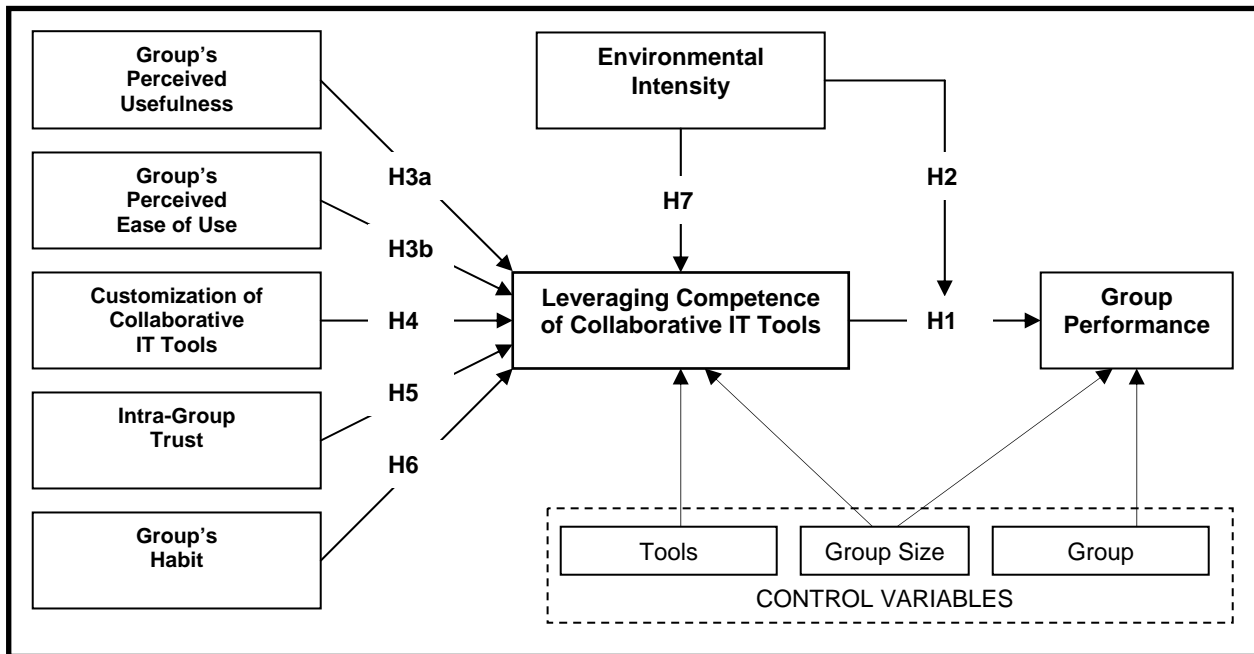
A review of numerous commercial software packages identified the core IT functionalities that are commonly found in collaborative IT tools: *workspace sharing*, *conferencing*, *file sharing*, *scheduling*, *chat*, and *email* functionality. Integrating these IT functionalities, Collaborative IT Tools Leveraging Competence is conceptualized as a formative second-order construct formed by the group’s effective use of these six key IT functionalities.

To show the business value of Collaborative IT Tools Leveraging Competence, we formally hypothesize its impact on group performance, and particularly on the group’s process efficiency, effectiveness, and situational awareness. The proposed impact of Collaborative IT Tools Leveraging Competence on group performance is hypothesized to be positively moderated by the degree of environmental intensity in which the group operates.

Finally, the study identifies the key factors that enhance a group’s Collaborative IT Tools Leveraging Competence. Extending the literature on the effective use of IT by groups, a set of antecedent variables is proposed, namely *technology acceptance* variables (the group’s perceived usefulness and ease of using collaborative IT tools), *technology* variables (customization of collaborative IT tools), *social* variables (the group member’s mutual trust), *post-adoption* variables (the group’s habit in using collaborative IT tools), and *environmental* variables (the degree of environmental intensity in which the group operates).

Figure 1 summarizes the antecedents and consequences of Collaborative IT Tools Leveraging Competence.

Figure 1. PLS Results of Proposed Research Model



This model offers a first cut at the key issues in ensuring that collaborative technology will provide benefits beyond the cost of the technology. The next steps in this research will be to estimate the actual return on investment of this technology within a test organization and to examine the potential real options (including risks and valuation of the options) this technology will provide to large organizations such as the Navy.

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Building Collaborative Capacity in the Interagency Context

Presenter: Gail Fann Thomas is an associate professor in the Graduate School of Business and Public Policy at the Naval Postgraduate School. She received an EdD at Arizona State University in Business and Education in 1986. She currently teaches strategic communication in the MBA program at NPS and in the Navy's Corporate Business Program. Since arriving at NPS in 1989, she has been involved in a numerous research projects that focus on management and leadership communication dilemmas.

Erik Jansen is a senior lecturer in the Graduate School of Operations and Information Sciences at the Naval Postgraduate School. In 1987, he received his PhD from the University of Southern California in organization and management. He currently teaches organizational theory and design and command and control. His research has been in the area of organizational design, emphasizing organizational reward systems and careers in the context of innovation.

Susan Page Hocevar is an associate professor in the Graduate School of Business and Public (GSBPP) at the Naval Postgraduate School. She received her PhD in organization and management at University of Southern California in 1989. She currently teaches courses in organizational behavior, negotiation and consensus building for programs in GSBPP, the NPS School of International Graduate Studies, and the NPS Defense Analysis program as well as the Navy's executive Corporate Business program. Her research programs currently include the ONR-sponsored Adaptive Architectures for Command and Control and inter-organizational collaboration.

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ABSTRACT

Federal Acquisition Reform has consistently called for more and better collaboration among participating organizations. Experience shows, however, that inter-organizational collaboration can be difficult at best. Our research focuses on imperatives of successful collaboration and aims to assist organizations in diagnosing their collaborative capacity. Based on prior research with homeland security, we offer a model of inter-organizational collaborative capacity grounded in a systems perspective. We then offer enablers and barriers that contribute to collaborative capacity. Finally, we describe how the ability to



diagnose collaborative capacity encourages literacy around collaboration and assists leaders in determining capabilities that the organization must develop to be successful in developing collaborative capacity.

BUILDING COLLABORATIVE CAPACITY IN AN INTER-ORGANIZATIONAL CONTEXT

Complex inter-organizational collaboration is characterized by high task uncertainty, multiple participants, virtual communication and diverse organizational goals. As organizations increase their dependence on one another and attempt to increase their performance, inter-organizational collaboration is viewed by many as an imperative. In the federal government, for instance, the Federal Acquisition Reform has consistently called for more and better collaboration among participating organizations. Partnering, Alpha Contracting, and Delta Contracting are but a few examples of innovative arrangements that currently are being used to increase inter-organizational collaboration among agencies.

In government and industry, collaboration is on the rise because it has been found to reduce litigation, decrease costs, and increase innovation (Mankin, Cohen, & Fitzgerald, 2004). Accordingly, some organizations have developed mature partnering arrangements or alliances and have demonstrated that these arrangements can save millions of dollars and significantly reduce cycle-time. Other organizations have not yet positioned themselves to leverage the benefits of collaborative relationships.

Our research focuses on imperatives of successful collaboration and aims to assist organizations in diagnosing their collaborative capacity. Diagnosing collaborative capacity encourages literacy around collaboration and assists leaders in determining capabilities that the organization must develop to be successful. This paper describes what we mean by the term “collaborative capacity,” explains key factors for successful collaboration, and shows how our diagnostic tool can leverage learning for an organization.

When is collaboration most beneficial?

Collaboration is most beneficial when organizations are interdependent and rely on each other to achieve a common goal or task. This reliance provides an opportunity for organizations to coordinate their work and find ways to work well with one another. While collaboration appears on the surface to be an obvious solution, experience shows that organizations commonly fail when they attempt to build collaborative relationships. Among the reasons for ineffective collaboration are: diverse missions, goals and incentives that conflict with one another; histories of distrust that are hard to alter; leaders who do not actively support collaborative efforts; and the lack of coordination systems and structures needed to support collaborative efforts (US Government Accountability Office, December 2002). Hurricane Katrina relief was a dramatic example of the consequences of failed collaborative efforts.

What is collaborative capacity?

Collaborative capacity, as it relates to interagency collaboration, resonates in the work of a number of academics and practitioners (e.g., Bardach, 1998; Huxham, 1996; Mowery, Oxley, & Silverman, 1996; Seidman, 1970). *Collaborative capacity is the ability of organizations to enter into, develop, and sustain inter-organizational systems in pursuit of*



collective outcomes. A capacity for collaboration enhances the probability of mission completion by leveraging dispersed resources. The benefits of developing collaborative capabilities include: cost savings through the transfer of smart practices; better decision making as a result of advice and information obtained from colleagues; enhanced capacity for collective action by dispersed units; and innovation through the cross-pollination of ideas and recombination of scarce resources (Hansen & Nohria, 2004).

Development of a Model of Collaborative Capacity

Drawing on relevant literature and other experts in the field, we deductively developed a framework to map the conditions for effective interagency collaboration. We try to capture the dynamic interaction among all of these factors in the image presented in Figure 1. This diagram shows two organizations (A and B) facing a problem in which they have some interdependent interest or responsibility. Each organization can be represented in terms of the five organization design components derived from Galbraith (2002). The arrows indicate the dynamic interaction among the system elements both within and between organizations as they contribute to the collaborative capability to meet inter-organizational goals.

The dynamic interactions occur in at least three domains. First, effective collaborative capacity requires that the five system design categories (Strategy, Structure, Incentives, Lateral Mechanisms and People) for each participating organization be aligned with each other and with the environmental requirement or challenge (cf. Nadler & Tushman, 1980). This is reflected in the arrows within each of the three pentagons. However, because the problem assumes interdependence among multiple organizations, developing collaborative capacity cannot be accomplished by focusing solely on the dynamics within each organization. Alignment also needs to occur among the system elements *across* organizations. Finally, temporary or permanent interagency structures are frequently established to better enable the collaborative response to the common problem. In such a case, a third domain of interaction needs to be developed so that the design characteristics of the interagency task force or team are not only internally consistent, but also are aligned with the primary organizations they represent (Hocevar, Thomas, & Jansen, 2006).



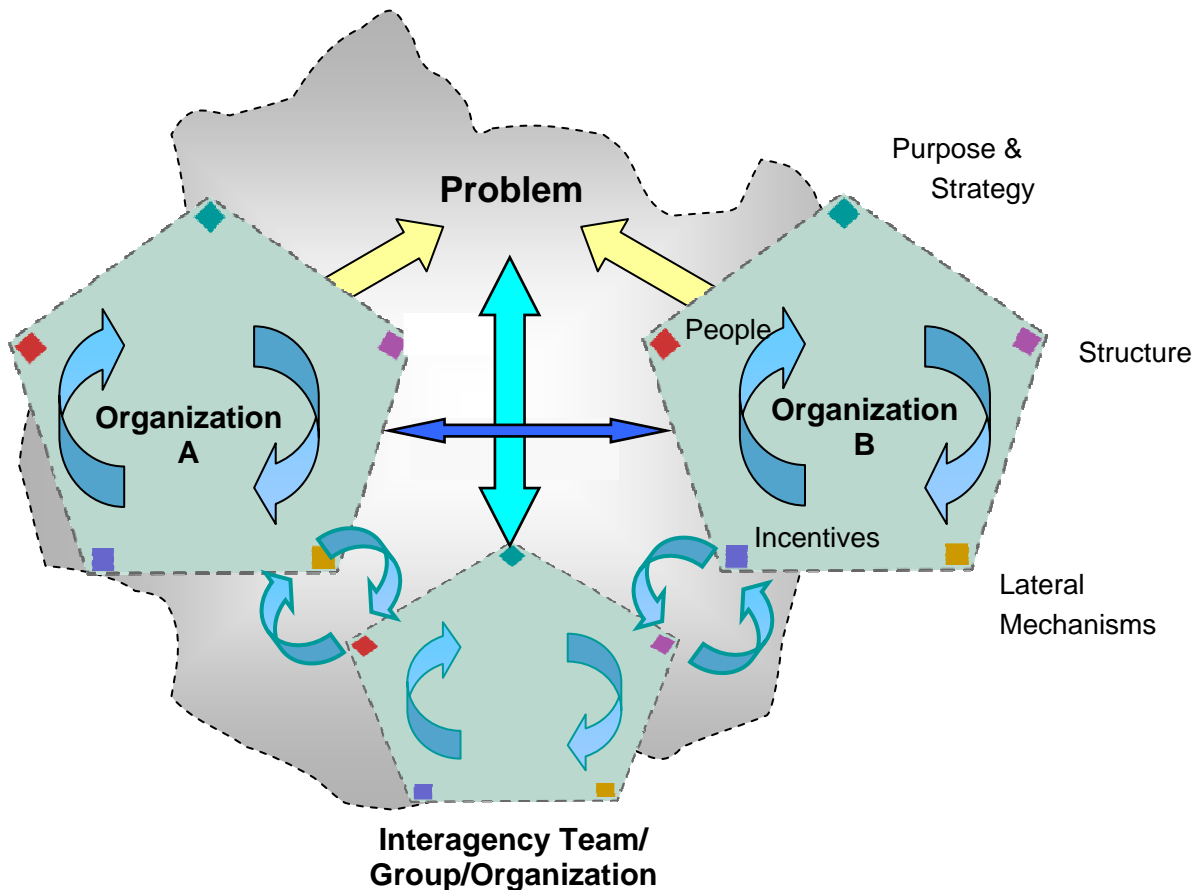


Figure 1. Developing Organization Design Dynamics to Improve Collaborative Capacity: an Innovative Strategy for DHS

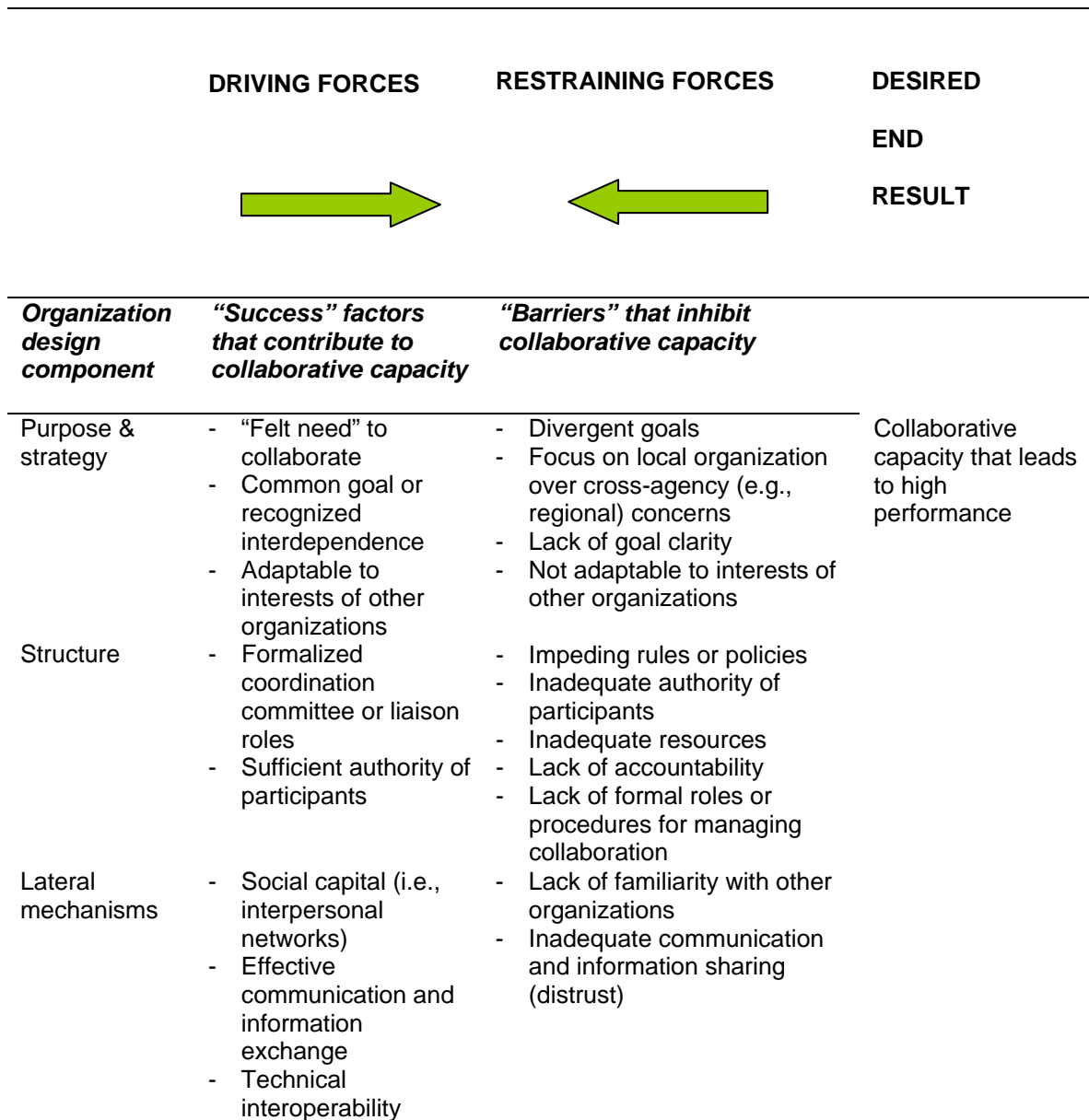
ENABLERS AND BARRIERS TO DEVELOPING INTERAGENCY COLLABORATION

Lewin's "force field" analysis model, developed over 50 years ago, is still viewed as the prominent way of explaining the forces of a change process (McShane & Van Glinow, 2005). In this case, Lewin's model provides a framework for examining the enablers and barriers to developing interagency collaboration. In a study of senior leaders in homeland security, Hocevar, Thomas, and Jansen (2004) identified key factors that explain success (enablers) and barriers to inter-organizational collaboration (see Figure 2). The left-hand column names the organization design component as identified in our systems model above. The column identified as "driving forces" lists the factors that contribute most to successful inter-organizational collaboration. The column identified as "restraining forces" includes the factors that impede collaboration.

The model demonstrates how driving forces and restraining forces work to maintain an equilibrium or status quo effect. If an organization chooses to increase its collaborative capacity, it must create a condition where the driving forces are stronger than the restraining

forces. This would mean that the driving forces must be strengthened and/or the restraining forces must be weakened or removed.

Figure 2. Force Field Analysis for Building Collaborative Capacity



Incentives	<ul style="list-style-type: none"> - Collaboration as a prerequisite for funding or resources - Leadership support and commitment - Absence of competitive rivalries - Acknowledged benefits of collaboration (e.g., shared resources) 	<ul style="list-style-type: none"> - Competition for resources - Territoriality - Organization-level distrust - Lack of mutual respect - Apathy
People	<ul style="list-style-type: none"> - Appreciation of others' perspectives - Competencies for collaboration - Trust - Commitment and motivation 	<ul style="list-style-type: none"> - Lack of competency - Arrogance, hostility, animosity

Enablers to Success

“Purpose and strategy” can be driven by a commonly perceived risk or threat (“felt need”) or a common goal such as improving information sharing or coordinated training. Accomplishing a shared purpose is enabled by the third factor in this category—the willingness to adapt the collaborative effort to the needs and interests of other participating organizations.

The “structural” component includes the formal power and authority of those engaged in an inter-organizational collaboration. We found that successful inter-organizational collaborations had formalized coordination of liaison roles, and players had sufficient authority.

“Lateral Mechanisms” are another factor that contributes to success. Social capital represents the interpersonal trust and exchange orientations that come from human interaction, which provides an important foundation for civic behavior (e.g., Adler & Kwon, 2002; Putnam, 2000). We classified social capital as a lateral mechanism within the organization design framework. Effective communication also was identified as a related lateral mechanism. Some characterizations of effective communication include: timely dissemination of information, free flow of information, and the establishment of communications systems and processes across organizations. Effective communication, along with the increased familiarity that comes with interpersonal networks, provides an important means for collaboration. In addition to human communication, technical interoperability contributes to success.

“Incentives” was the fourth category of success factors. In our study, collaboration often was a prerequisite for obtaining resources. For instance, agencies might be required to develop a multi-agency coalition in order to receive a grant. While this does not guarantee success, it creates an opportunity to develop other important collaborative capabilities. Collaborating in the development of a grant proposal is a focused, time-limited activity with clearly identified “payoffs.” The process of this effort can generate a better understanding of other organizations’ interests and capabilities, create social capital as interpersonal relationships are developed, and set the stage for the creation of temporary or permanent structures for collaboration and information exchange. Incentives to collaborate



can be achieved through mandates or external requirements for funding (Cummings, 1984). Another frequently mentioned incentive to collaborate was strong leadership. A leader who clearly expresses commitment to a vision of collaboration with other agencies can provide an important incentive for other organizational members to engage in this “new” activity. This is similar to the acknowledged role of leadership in effective change management (e.g., Kotter, 1990). Other success imperatives included an absence of competitive rivalries and an acknowledgement of the benefits of collaborative efforts.

The last category of success factors is “People.” A primary characteristic of those who participated in successful collaborative efforts was an appreciation of others’ perspectives. In other works, players were able to step outside their own narrow interests and appreciate other’s views. Players appeared to have developed competencies for collaboration and were able to build trust among the various players. Commitment and motivation were also keys to success.

Barriers to Collaboration

The identified barriers to collaboration substantially reinforce the factors identified as contributing to success, even though they are not an exact replication of the capabilities described above.

Under “Purpose and Strategy,” divergent goals were mentioned as an impediment to inter-organizational collaboration. Related to that was lack of goal clarity. Opposed to the earlier success factor of recognizing other’s interests, barriers arose when players focused on their own organization’s interests at the expense of a broader set of interests or a common goal. Even when others’ interests are recognized, the unwillingness or inability to adapt to interests of the other organizations was another barrier.

While mentioned less frequently, other barriers to effective inter-organizational collaboration were classified as Structural. Specific examples include: procedural prohibitions such as security classifications, lack of formal roles and procedures to enable collaboration, inadequate authority of participants to engage in negotiation or decision-making on behalf of their organization, and lack of accountability. Most of these are indicators of problems that can exist in “under-designed” systems (Cummings, 1984). Because well-established, institutional mechanisms for coordination are unlikely to exist or are likely to be underdeveloped in extra-organizational relationships, the importance of leadership, followership, and colleagueship (i.e., the capacity for mutual adjustment) is increased.

Two barriers were identified in the category of “Lateral Mechanisms.” “Lack of familiarity with other organizations” and “Inadequate communication and information sharing” both represent missing enablers of collaboration. Some participants identified distrust as a cause of inadequate communication. Distrust was sometimes characterized at the organizational level, as in “the organizations have a history of distrust.” As an organization-level phenomenon, we also view this as a disincentive to collaboration and, thus, categorized this factor as a barrier under “Incentives.” Other times, the participants attributed distrust to individuals; in this case, we categorized the factor into the design dimension of “People.” Behaviors that are both instigators and symptoms of distrust included “Arrogance, hostility, and animosity” in the People category and “Lack of mutual respect” when attributed to organizations (in the Incentives category).



Two other frequently cited barriers were “Competition for resources” and “Territoriality and turf protection.” These two factors were categorized as (dis)incentives. These factors are related to the Lateral Mechanisms and People factors described above. While the causal relationship is not definitive, a clear relationship exists among competition/territoriality and lack of familiarity, inadequate communication, and distrust. Together, these system dimensions can create a continuing cycle of dysfunction. When organizations are competitive, distrustful, or just unfamiliar with each other, this can impede necessary communications. The inadequacy of communications, in turn, continues the lack of familiarity, or in the more extreme cases, can increase distrust. This suggests that specific interventions to disrupt this cycle and shift the alignment toward constructive interactions are necessary to build collaborative capacity.

COLLABORATION-READINESS ASSESSMENT

Our current focus is the development of a collaboration-readiness assessment. The purpose of this phase of the research is to develop an assessment instrument to measure organizations’ collaboration readiness. This instrument will allow organizations to assess their capacity to engage in collaborative efforts and then provide specific activities for improving their collaborative capacity.

This diagnostic tool will derive from our collaborative capacity conceptual model and provide a means of measuring and assessing an organization’s collaborative capacity. The diagnostic tool is valuable in a number of ways:

- 1) It allows organizations to establish baseline measures and chart their development over time. Management can determine its collaborative capacity trajectory. In other words, where are they now? Where would they like to be? How long should it take to get there?
- 2) It enables organizations to become “collaboration literate.” The use of the tool introduces key terms and ideas related to inter-organizational collaboration.
- 3) Interventions can be developed to move the organization from where they are to their desired position. This might include selection of individuals with collaborative competences to pivotal roles that work across organizational boundaries. It might include training and management development.
- 4) The assessment process becomes a tool for creating dialog among organizational members about the value and development of collaborative capacity.

While our initial work to establish the model presented here was done in the domain of inter-agency collaboration for homeland security and defense, we see opportunities for its application in other areas (such as acquisition) where the quality of inter-organizational interactions can have significant impact on the quality of the defense product. Our goal is to design a readiness assessment tool that can be tailored to the specific collaboration requirements of different communities of practice. Our future research goals include the application and evaluation of the assessment tool in varying case environments.

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Panel – Analytic Approaches to Shaping the S&T Base

Wednesday, May 17, 2006	Analytic Approaches to Shaping the S&T Base
11:00 a.m. – 12:30 p.m.	<p>Chair:</p> <p>Dan Nussbaum – Naval Postgraduate School</p> <p>Discussants:</p> <p>Sue C. Payton – Deputy Under Secretary of Defense (Advanced Science & Concepts)</p> <p>Michael McGrath – Deputy Assistant Secretary of the Navy (Research, Development, Test and Evaluation)</p> <p>Fred Hartman – Director, Joint Assessment and Enabling Capability, Office of the Under Secretary of Defense (Personnel and Readiness)</p>

Chair: Dan Nussbaum – Professor, Naval Postgraduate School

Dr. Daniel A. Nussbaum is a Professor at the Naval Postgraduate School, in the Operations Research department, in Monterey, California. His expertise is in cost/benefit analyses, life cycle cost estimating and modeling, budget preparation and justification, performance measurement and earned value management (EVM), activity based costing (ABC) and Total Cost of Ownership (TCO) analyses.



From December 1999 through June 2004 he was a Principal with Booz Allen Hamilton, providing estimating and analysis services to senior levels of the US Federal government. He has been the chief advisor to the Secretary of Navy on all aspects of cost estimating and analysis throughout the Navy, and has held other management and analysis positions with the US Army and Navy, in this country and in Europe.

In a prior life, he was a tenured university faculty member.

Dr. Nussbaum has a BA, in Mathematics and Economics from Columbia University, and a Ph.D., in Mathematics from Michigan State University. He has held post doctoral positions in Econometrics and Operations Research, and in National Security Studies at Washington State University and Harvard University.

He is active in professional societies, currently serving as the President of the Society of Cost Estimating and Analysis. He has previously been the VP of the Washington chapter of INFORMS, and he has served on the Board of the Military Operations Research Society.



He publishes and speaks regularly before professional audiences.

Finally, he is married, has two children and four grandchildren. He is a lap swimmer and a dedicated herb and vegetable gardener.

Discussant: Sue C. Payton – Deputy Under Secretary of Defense (Advanced Science & Concepts)

Ms. Sue C. Payton is the Deputy Under Secretary of Defense (Advanced Systems & Concepts). In this role, she has oversight responsibilities for technology transition programs to include: Advanced Concept Technology Demonstrations, Joint Warfighting Program, Foreign Comparative Test, Defense Acquisition Challenge, Technology Transition Initiative, ManTech, Defense Production Act Title III, Dual Use S&T, and TechLink. Prior to taking this position in September 2001, Ms. Payton was the Vice President, Applied Technology of ImageLinks, Inc. and the Director of the National Center for Applied Technology, responsible for the assessment, prototype development and insertion of commercial technology for DoD agencies and field users. These prototyping efforts included support to NIMA, DIA, US Navy, JCS/J2, USSOCOM, USCENTCOM, AFSOC, USAF battle labs, NSA and NRO to rapidly bring emerging commercial technology to the warfighter.



From 1994 to 1996, Ms. Payton was responsible to the Vice President of Business Development, Lockheed Martin, for leveraging the latest information systems technology to meet the program needs of customers including NIMA, NRO, AF/ESC, Rome Laboratory, USACOM, ONI/NMIC, NAIC and National Systems Providers. From 1989 to 1994, Ms. Payton was the Senior Site Systems Integration Manager for Martin Marietta responsible for resolving complex technical issues associated with systems analysis and trade studies of competing Space and Ground Architectures, operations concepts, requirements definition, software test and transition to operations.

Ms. Payton has extensive experience leading government and industry partnerships focused on applying commercially-based technology to solve IC and DoD C3I information access, analysis and delivery problems. She has been an invited briefer and panel member for the US Space Foundation, NIMA Defense Science Board, National Technology Alliance Executive Board, AFCEA Intelligence Committee, Joint Requirements Oversight Council, Defense University, JCS/J2 and DIA senior leaders, CIA DDS&T, USCENTCOM Battlespace Visualization senior staff and Office of Naval Research. She is the US R&D Principal for the Declaration of Principles for Industrial Cooperation with the UK and Northern Ireland, Chairman of the Personnel Recovery Technology Working Group, a member of the Defense Science and Technology Advisory Group (DSTAG), National Technology Alliance Executive Board, and Purdue University President's Council. She has served in various capacities with the Open Geospatial Consortium and the National Correlation Working Group.

Ms. Payton received a BS from Eastern Illinois University, and an MS in Systems Management/Systems Technology from the University of Southern California. She is a 1998 graduate of the Goizueta Business School, Emory University Executive Program.



Discussant: Michael McGrath – Deputy Assistant Secretary of the Navy (Research, Development, Test and Evaluation)

Dr. Michael McGrath was appointed as the Deputy Assistant Secretary of the Navy for Research, Development, Test and Evaluation in February, 2003. His role is to aggressively drive new technologies from all sources across Navy and Marine Corps platforms and systems, and to develop programs to bridge the gap in transitioning from Science and Technology to Acquisition. He is also responsible for developing new ways to integrate Test and Evaluation (T&E) with the evolutionary acquisition process.

Prior to his appointment to this position, Dr. McGrath spent five years as Vice President for Government Business at the Sarnoff Corporation, a leading R&D company with both commercial and government clients. He was responsible for program development across all Sarnoff business units to meet government needs for innovative dual use technologies in sensors and microelectronics, networking and information technology, and bio-technology.

Dr. McGrath has 28 years of prior government experience. His early career was in weapon system logistics planning and management, first at the Naval Air Systems Command, and later in the Office of the Secretary of Defense, where he developed policies for Integrated Logistics Support and reviewed implementation in major weapon system acquisition programs in all three Military Departments.

He was appointed to the Senior Executive Service in 1986 as Director of the OSD CALS Office, where he guided the Computer-aided Acquisition and Logistics Support program from its inception. Five years later he became the Assistant Director for Manufacturing in DARPA's Defense Sciences Office, where he managed programs in Agile Manufacturing, Electronic Commerce Resource Centers, and Affordable Multi-Missile Manufacturing. He also served in leadership positions for several DoD-wide initiatives to improve manufacturing and reduce the cost of defense systems. In 1996-97 he served as the Assistant Deputy Under Secretary of Defense (Dual Use and Commercial Programs), where he directed the Commercial Technology Insertion Program, the Commercial Operating and Support Savings Initiative, and the Department's Title III industrial base investments.

Dr. McGrath holds a BS in Space Science and Applied Physics (1970) and an MS in Aerospace Engineering (1972) from Catholic University, and a doctorate in Operations Research from George Washington University (1985). He has been active in several industry associations and study groups, including studies by the Defense Science Board and the National Research Council.

Discussant: Fred Hartman – Director, Joint Assessment and Enabling Capability, Office of the Under Secretary of Defense (Personnel and Readiness)

Mr. Fred Hartman is currently Director, Training Transformation Joint Assessment and Enabling Capability (JAEC) and Deputy Director, Readiness and Training Policy and Programs (RTPP) for the Office of the Under Secretary of Defense, (Personnel and Readiness).



Mr. Hartman attended the Missouri School of Mines and Metallurgy and began his military career on entering the United States Military Academy, graduating with a Bachelor of Science degree. He earned a Master of Science degree in Operations Analysis from the Naval Postgraduate School. During the five years prior to working for his advanced degree, Mr. Hartman attended Army courses in Field Artillery and Aviation. He commanded an Artillery Battery in Korea and flew intelligence missions for the Military Assistance Command Vietnam (MACV). As a military operations research analyst in the Army, Mr. Hartman was the model manager for a high-resolution combat simulation and developed a study methodology for a major Army study, Management of Change, combining automated network analysis techniques with traditional management tools to solve complex force structure allocation problems. While on active duty, Mr. Hartman served as a procurement programs analyst in Army Program Analysis and Evaluation and as executive assistant and analyst for the Deputy Under Secretary of the Army (Operations Research).

Mr. Hartman left active duty and joined CACI, Inc in 1981 and progressively grew from Department Manager to Executive Vice President by building an analysis group consisting of professionals in operations research, software engineering, logistics engineering, financial analysis, and software development with annual revenues in excess of \$25M. During this ten-year period, Mr. Hartman conceived, designed and developed a family of resource predictive models for training applications, and developed through a series of simulations and data applications, the overarching framework for a high-level decision support system for Army Headquarters. Mr. Hartman also developed automated simulations and tools supporting both Army and Naval aviation logistics systems and performed Cost and Operational Effectiveness Analyses (COEA) for the aviation industry.

Mr. Hartman was chief operating officer, co-founder and board member for Applied Solutions International, Inc from 1992 to 1995. This start-up technology company served as consultants specializing in services for the defense industry, commercial clients and international trade. In 1993 Mr. Hartman led an evaluation mission for automated manufacturing in Beijing and Shanghai, China for the United Nations Development Programme (UNDP). The UNDP mission evaluated two transducer research and development programs for automated manufacturing applications.

In 1995 Mr. Hartman joined the Institute for Defense Analyses as a modeling and simulation consultant to the Deputy Under Secretary of Defense (Readiness), primarily responsible for oversight and coordination of the training modeling and simulation programs. In the spring of 2000, Mr. Hartman became an IPA as Technical Director and led the architecture group for the Joint Simulation System (JSIMS) program transition team. In the summer of 2003 Mr. Hartman returned to DUSD (R) as Associate Director for Modeling and Simulation and to lead the Training Capabilities Analysis of Alternatives. In 2004 he assumed duties as the Director of JAEC, and in 2005 undertook additional responsibilities as Deputy Director RTPP.

Mr. Hartman served for six years as a member of the Army Science Board, led a study panel for the National Academy of Sciences Board on Army Science and Technology, and is a past President and Fellow of the Military Operations Research Society.



Panel – Strategic Sourcing

Wednesday, May 17, 2005	Strategic Sourcing
11:00 a.m. – 12:30 p.m.	<p>Chair:</p> <p>Charlie Williams Jr. – Deputy Assistant Secretary of the Air Force (Contracting)</p> <p>Discussant:</p> <p>David Burt – University of San Diego (emeritus)</p> <p>Papers:</p> <p><i>DoD is Not IBM: The Challenges of Implementing Strategic Sourcing in Defense Acquisition</i></p> <p>Dan Bowman, Air Force Material Command</p> <p>Lt Col Timothy S. Reed, USAF, 325th Contracting Squadron, Tyndall AFB</p> <p>Lt Col Bryan J. Hudgens, USAF, Naval Postgraduate School</p> <p>Maj David Searle, USAF</p> <p><i>Strategic Sourcing in the Public Sector</i></p> <p>Walter N. Quade, Commonwealth of Pennsylvania</p>

Chair: Charlie Williams Jr., Deputy Assistant Secretary of the Air Force (Contracting)

Mr. Williams, a member of the Senior Executive Service, is Deputy Assistant Secretary for Contracting, Office of the Assistant Secretary of the Air Force for Acquisition, Headquarters US Air Force, Washington, DC. Mr. Williams is responsible for all aspects of contracting relating to the acquisition of weapon systems, logistics support, materiel and services for the Air Force. Additionally, Mr. Williams is the US member to the North Atlantic Treaty Organizations Airborne Early Warning and Control Programme Management Organizations Board of Directors.

Mr. Williams was born in Nashville, Tennessee. He holds a Bachelor of Science degree from Middle Tennessee State University, Murfreesboro, and a Master's degree from Tennessee State University, Nashville. He is also a 1996 graduate of the Industrial College of the Armed Forces, where he earned a second Master's degree in National Resource Management. In addition to his formal education and training, Mr. Williams was assigned to the General Electric Aircraft Engines Division, Cincinnati, Ohio, as a member of the Education with Industry Program.

Mr. Williams entered federal service in 1982 as a member of the Air Force Logistics Command Mid-level Management Training Program at Kelly Air Force Base, Texas.



DoD is Not IBM: The Challenges of Implementing Strategic Sourcing in Defense Acquisition

Presenter: Dan Bowman is the director of Purchasing and Supply Chain Management Implementation for Air Force Materiel Command at Wright-Patterson AFB, OH. Mr. Bowman is responsible for the revision of USAF depot maintenance, strategic purchasing, and supplier & customer interfaces. He was recently the Chief, Procurement Transformation, Pentagon.

Lt Col Timothy S. Reed, USAF, is the Commander, 325 Contracting Squadron, Tyndall AFB. He is responsible for \$500M in support of F-15, F-22, and AWACS flight training. He has served as Deputy Chief, Procurement Transformation Division, Pentagon, responsible for implementing strategic sourcing and commodity councils for DoD and USAF. Lt Col Reed holds a PhD in Strategic Management.

Lt Col Bryan J. Hudgens, USAF, is a Military Lecturer, the Air Force Acquisition Representative, and the Academic Associate (Program Director) for the Master of Executive Management Program in the Naval Postgraduate School's Graduate School of Business and Public Policy. He has experience in operational, contingency, and systems contracting, where he has served as both an administrative and a procuring contracting officer.

Maj David Searle, USAF, is a student at the Air Command and Staff College at Maxwell AFB, AL. He recently served as the lead contracting officer on an Air Force commodity council. His Force Protection Commodity Council was responsible for the strategic purchase of guard services at over 35 installations.

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Abstract

In this paper, we examine the initial efforts to instill a strategic purchasing mindset in defense organizations and to create commodity councils whereby strategic sourcing might be executed. Our analysis has determined that there are at least three primary barriers to successful implementation of strategic purchasing in DoD acquisition. First, products or services that may be easily “commoditized” by industry are subject to many more constraints which limit or obviate the ability for the Government to leverage its spend. Second, the additional regulations and statutes which the DoD must comply with (such as the Buy American Act, Davis-Bacon, and Small Business Rules) limit the opportunities to pursue leveraged buying. Third, there is no single voice responsible for the organization spend, or with the ability to dictate and enforce strategic acquisition programs. This paper offers potential solutions for each of these challenges.

Introduction

One can argue the Department of Defense has always faced a fiscal crisis. Year after year, the DoD engages in a “guns versus butter debate” in competing with other agencies for the defense slice of the budget. The debating then shifts to the internal grappling between the services fighting for their parochial piece of the pie. Simply put, there has never been enough to go around. Subsequently, policymakers have always had to make tough budget decisions. Throughout the 90’s following the end of the Cold War, defense budgets were in a steady decline. Between 1990 and 1997 outlays dropped nearly 26% in real terms (OSD, 2007). Between 1984 and 1998, the defense budget authority declined in real, inflation-adjusted dollars. Over the last five years, the budget shows what appears to be a slight increase in defense outlays, but these increases have included increased costs for the Global War on Terrorism, the requirements for maintaining a heightened vigilance, and requirements levied in support of homeland security. In fact, between September 11, 2001 to May 2005, the DoD spent approximately \$190B in support of these efforts.

To further compound the problem, upward pressures on defense spending are substantial. First, the DoD faces pressures to modernize and recapitalize many of its weapon systems. The Department went through a “draw down” following the Cold War and achieved mandated reductions in defense spending primarily through reductions in its procuring activity. The Department sacrificed acquisitions to free funds for operational readiness. As a result, many of its current weapons systems are nearing the end of their useful life and will soon require replacement. Secondly, the DoD has continuing “must pay” obligations. These include health care costs for retirees, active duty troops and their families, and rising personnel costs. The fact of the matter is that it costs more to maintain a military force each year; in fact, most defense costs rise faster than inflation. Nevertheless, budget cuts continue. In January 2005, Deputy Secretary of Defense Paul Wolfowitz issued Program Budget Decision 753. The decision identified \$30 billion of additional cuts in planned defense spending through 2011. In March 2005, then Air Force Chief of Staff Gen. John P. Jumper predicted a \$3 billion shortfall in FY2005 operations and maintenance funds (Byron, 2004). There are simply too few dollars available to support current military operations, modernization efforts, and “must pay” bills.

Naturally, within such a fiscally constrained environment, the focus of criticism shifts inwards towards an agency’s business practices. When faced with enormous fiscal pressures and a growing budget deficit, agencies focus on revamping business processes



to get the most out of every dollar spent. “For nearly four decades, Congress, the media and the White House have figuratively and literally hammered the Department of Defense (DoD) and the military services for waste and inefficiencies in buying” (Gottlieb, 2004). The message hasn’t fallen on deaf ears. For years the Department of Defense has recognized cost inefficiencies in its acquisition and procurement practices. In fact, regulations to control defense procurements extend as far back as the 1940’s. The Armed Services Procurement Act of 1947 was essentially the first formal unified defense procurement policy to be established (Gates, 1989; Gansler, 1989). Early procurement reform efforts in the DoD focused on coordinating procurement reform among the services. The various services’ missions were ambiguous, inter-service competition was high, and in a number of areas procurement programs overlapped (Acker, 1980; Gates, 1989). Over the last 30 years, there have been over 20 major regulatory and administrative initiatives implemented by Congress and the DoD that were intended to improve cost inefficiencies in defense procurement processes. In 2001, the Office of Management and Budget presented to congress the President’s Management Agenda which delineated a strategy for improving the management and performance of the federal government. The plan concluded the need for reform as urgent.

As a follow-up effort, the GAO assessed the President’s Management Agenda in an April 2005 testimony to the US Senate. They found a continuing need for broad-based transformations to address major economy, efficiency, and effectiveness challenges in a number of the government’s business process. DoD business processes need to change in order to more effectively deliver warfighting capabilities, address growing pressures on resources, and benefit from economies of scale. Procurement transformation is nothing new.

The Air Force’s commodity council initiative represents one of the more recent and promising strategic purchasing efforts. Fundamentally speaking, the general premise of a commodities council rests on developing strategies to maximize value by leveraging an organization’s buying power in a given commodities sector. According to Mr. Charlie Williams, the Air Force’s Deputy Assistant Secretary for Contracting, “despite the huge buying power our Air Force dollars should have, we are missing opportunities to leverage our dollars by relying heavily upon local strategies and execution to fulfill individual unit requirements” (Karas, 2004). Recognizing the potential of a proven industry practice, the Air Force established its first council in June 2003 focusing on Information Technology products. To date, the IT Commodity Council reports savings of approximately \$34 million. In 2004, the AF stood up additional councils targeting force protection and medical services. Unfortunately, these councils are in the early stages, and the AF has not quantified savings.

The overall goal of this paper is to provide the DoD with an understanding of differences between DoD and private procurement activities and to demonstrate that strategic purchasing efforts in the DoD may not achieve the same gains or benefits realized by those in the private sector. There are several barriers to successfully implementing strategic purchasing methods within DoD acquisitions. These barriers may obviate or negate the potential of one of industry’s most promising procurement practices. While strategic purchasing in the DoD certainly appears promising, policymakers need to understand the difference between private and public commodity councils lest their expectations become unsupported and unreasonably optimistic. Unrealized expectations could jeopardize other valid and necessary transformation efforts, could foster a lack of faith in benchmarking proven industry practices, and could lead to a loss of confidence and



support from the taxpayer. A key component of the federal acquisition system, in part, is to deliver “the best value product or service to the customer, while maintaining the public’s trust.” Also, policy makers need to understand these differences in conducting cost-benefit analysis on strategic purchasing initiatives. They may find the rewards unable to justify the costs of their business efforts.

Industry’s Approach

In their struggles to remain profitable, commercial organizations face similar fiscal pressures and dynamics. Market dynamics, competing firms, consumers and stockholders drive organizations towards efficiency and profitability. Cost control in the commercial marketplace is a fundamental business practice. With that in mind, purchasing costs can represent a relatively substantial percentage of an organization’s total operating costs. In some cases, the purchases of outside goods and services can consume as much as 60% or more of a business’ revenues. For example, at Hewlett-Packard, 70% of revenues are used to buy materials for production (Carborne, 2004). At IBM, the budget for purchasing is over 50% of the company’s annual revenue (Carborne, 1999). Gabbard (2004) found outside materials and services accounted for almost 70% of average corporate expenditures. Consequently, modest reductions in purchasing costs can yield substantial rewards—all which contribute to the bottom line.

As a result, over the last 30 to 40 years, leaders have been paying increasing attention to the procurement process and its relationship to profitability. The increased attention to purchasing has led to a dramatic shift in how organizations buy goods and services. Researchers show the procurement process has evolved over the years from what was once a tactical and clerical function to what is now a more strategic endeavor (Rendon, 2005). A series of external events shaped the context. An oil embargo and basic raw material shortages in the 1970’s, an interest rate spike and manufacturing crisis in the 1980’s and a slowly growing demand coupled with rising overhead costs and weak pricing power in the 1990’s pushed the purchasing department to the forefront. Porter describes these series of structural, economic and business shifts, along with global competition and flat revenues as strengthening the argument for total corporate spend control (Porter, 2003).

In desperate attempts to retain profitability, corporate leaders emphasized cost cutting and turned to the purchasing functions to make it happen (Staff, 2002). In a 2002 survey, over 90% of procurement professionals stated they were directed to help reduce their company’s costs and that pressures to do so have escalated over the preceding 5 years (Staff, 2002). This same survey found the overall cost-reduction goal for manufacturing companies averaging 12% (Staff, 2002). The 90’s became the decade of change as businesses widely recognized the supply chain as the answer to lower costs, increased profitability and increased competitiveness. In order to gain a competitive edge in the marketplace, procurement leaders had to develop a strategic orientation to the procurement process (Rendon, 2005). Within this framework, procurement professionals developed the procurement approach collectively referred to as strategic sourcing.

Strategic Sourcing

Organizations saw the potential of realizing significant cost reductions and other value-added outputs using strategic sourcing principles. Previous purchasing techniques were more tactical and focused more on independent, localized “wins.” Strategic sourcing takes a broader view of a purchase within the context of the entire organization and



examines the potential broader, longer-term gains. “It involves taking a more strategic approach to the selection of suppliers—an approach that is more aligned with the organization’s competitive strategy (Rendon, 2005). Newhart (2006) defines it as “a logical and systematic process for managing and prioritizing an organization’s spend.” The US government’s definition strikes a similar chord. According to the Office of Management and Budget (2005), strategic sourcing is the “collaborative and structured process of critically analyzing spending and using this information to make business decisions about acquiring commodities and services more effectively and efficiently.” Overall, the strategy is fundamentally about getting more for your dollar—certainly a reasonable response when operating within a fiscally constrained environment. Commercial procurement leaders use strategic sourcing tools to reduce costs and increase operating efficiencies (Sullivan, 2006). Regardless of which definition one clings to, the essence of strategic sourcing centers on two fundamental precepts: 1) spend analysis, and 2) leveraging.

Spend analysis involves a collaborative and structured process for critically analyzing an organization’s spending data. “It is the process of aggregating, cleansing, and analyzing corporate spending data for the purposes of reducing costs and improving operational performance” (Gabbard, 2004). Fundamentally speaking, it requires organizations to identify what goods or services are being purchased, who requires them, and who is currently getting the money (who are the suppliers) (Heath, 2006). The principle rests on the understanding that purchasers must first understand every element of company spend and then evaluate the commodity and how it is being procured. This investigation includes market research and industry analysis. A thorough understanding of spend data allows an organization to then exploit the information by leveraging the organization’s collective buying power in the marketplace to obtain the lowest price for goods and services. Leveraging is a key component of strategic sourcing. It improves an organization’s buying power with contractors and enables it to expect value-added outputs such as better quality, responsiveness and service in addition to reduced costs (Heath, 2006). The object of leveraging is to exploit volume, which is the main determinant of a company’s overall bargaining power. Organizations achieve volume and leveraging by consolidating contracts and aggregating spend with fewer suppliers (Patton, 2006; Gabbard, 2004). “Leverage or buying power is, by far, the most frequently cited benefit of greater purchasing centralization” (Porter, 1999).

The Path towards Strategic Purchasing in the DoD

Every purchasing situation is unique. Consequently, procurement strategies will differ depending on a number of internal and external factors. Internal factors are those that reflect the goals of the buying organization such as cost reduction, improved quality, the value of the item, etc. External factors are those market dynamics and other factors that may impact the overall effectiveness of the product or service being sourced. These include things such as the complexity of the market or the availability of a commodity, for example. Using a strategic sourcing approach, buyers consider these factors and their influence on the procurement approach (Kraljik, 1983). The purchaser’s task then becomes tailoring a sourcing strategy for a specific commodity that best exploits the buying organization’s leverage in a given context. Peter Kraljik, a business consultant, developed a comprehensive, contingency-based model to assist purchasers in selecting appropriate sourcing strategies based on two variables: (1) the strategic importance of purchasing in terms of the value added by the commodity (cost of materials, value-added profile, profitability, etc.), and (2) the complexity of the supply market in terms of commodity availability, entry barriers, monopoly or oligopoly conditions, pace of technological advance,



etc. (Figure 1) (Kraljik, 1983). Viewed through another lens, the first variable (importance of purchasing) translates to profit impact. One can view the second variable (complexity of supply market) as supply risk.

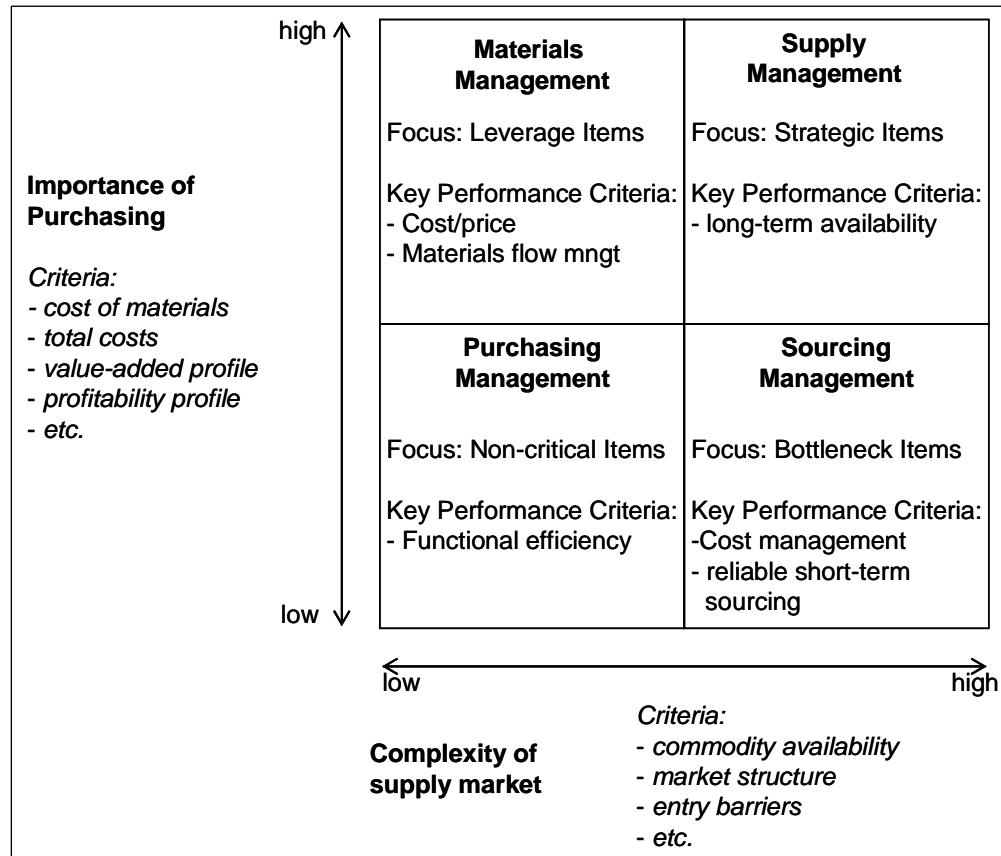


Figure 1. Sourcing Strategies (Kraljik, 1983)

As a commodity group, leverage items typically represent approximately 70% of a company's total expenditures (Gabbard, 2004). Within this segment, the market has large capacity and offers many alternatives and many sources. Additionally, the confluence of high purchasing volume and market availability position the procurement organization in a much better negotiating position. Items in this sector are, therefore, often exploitable and offer higher profitability profiles (higher potential of returns) than items in the lower sectors.

Strategic items also offer the potential for high payback. These items are vital to the ongoing operations of the company and represent approximately 20% of the dollars expended by a company (Gabbard, 2004). Compared to leverage-item purchases, though, there are fewer, large expenditure transactions for these items. Procurement experts characterize this segment as one with greater supply risk as there are fewer suppliers available and often barriers to entry (Kraljik, 1983).

Experts frequently categorize the non-critical items sector as a buyer's market. These items typically only constitute approximately 5% of a company's spend (Gabbard, 2004). The market offers many options and multiple suppliers, and buyers typically have

little brand preference. Profit impact and supply risk for this segment are both low. The last category, bottleneck items, also represents only about 5% of a typical organization's spend (Gabbard, 2004). Supply risk is high as there are typically few sources and options available, and profit potential is low.

Inherent in Kraljik's model is the premise that there is no "one size fits all" approach to procurement. The purpose of the model is simply to ensure procurement officials integrate and align sourcing strategies with the overarching competitive strategy in order to develop an overall strategic supply position that balances competitive goals against supply conditions. With upwards of 90% of purchasing offices operating under the corporate direction to cut procurement costs, and with cost reduction goals as high as 12% on corporate spend, organizations logically placed emphasis on the strategies identified in the upper quadrants—materials management and supply management. Sourcing strategies for these categories of commodities offer higher profitability profiles than those in the lower quadrants. Leverage items have high profit impact with low supply risk, while strategic items have high profit impact and high supply risk. When a principal goal of an organization is slashing procurement costs, focusing on leverage items and strategic items is appropriate.

"Leverage Items"

Leverage items offered an attractive starting point for procuring offices anxious to smartly reduce procurement costs. Market capacity is large, as is the potential pay-back. With such a large percentage of corporate costs tied to leverage items, the potential rewards of even small percentage gains can be enormous. For example, in 2004, Hewlett-Packard spent nearly \$43B on production materials (Carbone, 2004). A modest 1-2% cost reduction in purchasing costs could yield nearly \$1B on the bottom line. As indicated by the strategy's focus for leverage items, the core task involves exploiting the full purchasing power of the organization to increase its bargaining power through leveraging. "Most procurement experts believe 15-20% of purchased materials and services can be saved (billions of dollars in a large company) by centralizing procurement and leveraging a far-flung corporation's buying power" (Richter, 2003).

Commodity Councils

Industry developed the commodity council approach to maximize the strategic sourcing decision across the spectrum of available strategies. A commodity council is a cross-functional team that develops strategies for individual commodity groups by analyzing spend data, defining customer requirements, and conducting market research. "In developing its strategy, the goal of a council is to help maximize the firm's competitive advantage by extracting the maximum value for the commodity from its suppliers" (Ausink, Baldwin, & Paul, 2003). In other words, councils are responsible for meeting the internal customer's needs at the lowest total cost. Their principal purpose is to leverage spending at the enterprise level primarily through large lot discounting, but discounts can also be realized through process efficiencies and reduced transaction costs. The team is typically composed of a variety of experts and key stakeholders in the company who work full time on the commodity team. The most successful teams understood the decision as too important to be assigned as an additional duty; therefore, members were fully committed to the team (Heath, 2006). Organizations used commodity councils to ensure they had the appropriate knowledge mix, credibility, and technical expertise.

Between 2002 and 2003, the Government Accountability Office studied procurement best practices of eleven companies—each a leader in their respective market. They found



that companies adopted a strategic approach to “leverage their buying power, reduce costs, better manage their suppliers, and improve the quality of goods and services acquired” (GAO, 2004). On average, these 11 companies realized up to 20% in procurement cost savings. The study identified the following four broad principles and best practices for commodity councils: (1) Secure up-front commitment from top leaders; (2) Obtain improved knowledge on procurement spending; (3) Create supporting structure, processes, and roles; and (4) Enable success through sustained leadership, communication, and metrics. (Figure 2) Lasseter identified similar steps in his sourcing model. His “balanced sourcing model” describes a process that ensures competitive pricing from suppliers while simultaneously nurturing a cooperative buyer-seller relationship. He suggests the following seven activities as broad guidelines to be used by a council when developing a particular commodity strategy: (1) Spend analysis, (2) Industry analysis, (3) Cost/performance analysis, (4) Supplier role analysis, (5) Business process reintegration, (6) Savings quantification, and (7) Implementation (Lasseter, 1998). With the exception of the savings quantification step in Lasseter’s model, both models address the same fundamental best practices. Lasseter suggests savings quantification is one of the more critical steps as it lends credibility and support to the proposed strategy and can be used to gain the support of upper management. Although challenging, documenting savings is paramount in order to show success in centralized procurement (Stephens, 2005). By developing a cost-savings model as part of the sourcing strategy, buyers build a case for taking a consolidated approach. It justifies the actions and allows senior managers to realign resources to more effectively support other mission priorities (Heath, 2006).

<p>Commitment...<i>Secure up front commitment from top leaders</i></p> <ul style="list-style-type: none"> • Recognize and communicate the urgency to change service spending practices • Provide clear and strong executive leadership, including goals and targets
<p>Knowledge...<i>Obtain improved knowledge on service spending</i></p> <ul style="list-style-type: none"> • Develop information system to identify how much is being spent with which service provider for what services • Analyze the data to identify opportunities to reduce costs, improve service levels, and provide better management of service providers
<p>Change...<i>Create supporting structure, processes, and roles</i></p> <ul style="list-style-type: none"> • Create or identify organizations responsible for coordinating or managing service purchases • Establish proactive business relationships between end users, purchasing units, and other stakeholders • Implement more integrated team-based sourcing processes • Create commodity/service experts
<p>Support...<i>Enable success through sustained leadership, communication, and metrics</i></p> <ul style="list-style-type: none"> • Obtain sustaining support from senior leadership to facilitate change • Establish clear lines of communication between all affected parties • Demonstrate value and credibility of new processes through use of metrics

Figure 1. GAO Analysis: Industry Best Practices (GAO, 2004)

Industry’s Success

Of course, the greatest measure of the potential of an industry practice is in the demonstrated results. Table 1 identifies just a few of the companies who have leveraged their corporate spend through centralized procurement and presents the results of their



efforts. Leading procurement organizations operate, on average, with 46% fewer suppliers than typical companies and concentrate 80% of their spend on just 5.9% of their suppliers (Staff, 2005). This concentration of spend not only improves an organization's negotiating leverage but also fosters collaborative buyer-seller relationships which can remove non-value added costs and identify other areas for improvement. These two key concepts (consolidating enterprise-wide volume and concentrating the supply base) have become industry's mantra in its strategic sourcing initiatives.

Company	Actions and Results
IBM (Carbone, 1999)	<ul style="list-style-type: none"> - consolidated requirements of all its divisions and locations - established 17 councils' charter with reducing the number of suppliers and reducing costs - reduced the number of suppliers from ~4,900 in 1993; now about 85% of IBM's \$17.1B in production purchases is with 50 suppliers - realized pricing discounts 5-10% below industry average
Hewlett Packard (Carbone, 2004)	<ul style="list-style-type: none"> - centralized purchasing of key commodities - top priority was to leverage their size and scale to cut costs - reduced the number of direct material suppliers by 53% from 1500 to 720 - spend 85% of their procurement dollars with just 35 suppliers - realized \$1.2B in savings from 2001 to 2004
Brunswick Corp. (Avery, 1999)	<ul style="list-style-type: none"> - centralized purchasing of six distinct units - set specific cost reduction goals - from 1997-1998 reduced procurement costs \$2.7M on \$22M in annual spend
Lucent Technologies, Inc. (Carbone, 2002)	<ul style="list-style-type: none"> - top priority was consolidating their purchases and reducing the number of suppliers - developed sourcing strategies for ~20 commodities - from 2000 to 2002, reduced the number of suppliers from over 3,000 to less than 1,500 - spend 80% of their procurement dollars with just 60 suppliers - reduced procurement costs up to 55%
Bristol Myers Squibb (Newhart, 2006)	<ul style="list-style-type: none"> - top priority was consolidating their purchases and reducing the number of suppliers - developed sourcing strategies for ~20 commodities - from 2000 to 20002 reduced the number of suppliers from over 3,000 to less than 1,500 - spend 80% of their procurement dollars with just 60 suppliers - reduced procurement costs up to 55%

Table 1. Industry Strategic Sourcing Efforts: Actions and Results



Benchmarking Industry

According to the Office of Management and Budget, the federal government spends approximately \$300 billion on goods and services each fiscal year. In FY2004, the DoD procured nearly \$230 billion in goods and services (OSD, 2007). The Air Force's share was approximately \$55.2B with approximately half of its budget allocated toward purchased goods and services. "A modest 1 percent to 2 percent reduction would produce savings equivalent to the annual revenues of a Fortune 500 company" (Sullivan, 2006). Accordingly, maximizing value for taxpayers is an explicit top priority for the DoD and the OMB. Based on industry's demonstrated successes with commodity councils, it's no wonder the federal government sought to benchmark the practice. In May 2005, David H. Safavian, Administrator for Federal Procurement Policy, said "the use of strategic sourcing is designed to get better pricing when the government buys commodity items. Strategic sourcing is just another example of our efforts to best leverage the government's buying power and to realize the most savings for taxpayers" (OMB, 2005). Similarly, the top program objective for the DoD's department-wide strategic sourcing program is a reduction in total cost of ownership. Like industry, the overall purpose of DoD strategic purchasing initiatives is to leverage purchasing volume to reduce purchase costs and to improve other value-added areas such as better customer support, increased quality, and accelerated delivery responsiveness.

Barriers to Successful Strategic Purchasing Within the DoD

Industry's objectives throughout the development of strategic purchasing approaches were clear. Above all, senior managers sought to improve profitability by leveraging corporate buying power, and the results validated their decisions to centralize procurement activities. While the potential of massive cost savings reductions is extremely attractive to the DoD, policymakers must understand the Department is not IBM. The DoD and other federal agencies have unique characteristics which may hinder the successful implementation of private-sector strategic purchasing best practices. These characteristics include having a commodity portfolio that may not allow for leveraging opportunities, procurement statutes that counter leverage-buying principles, an organizational structure that lacks a chief procurement officer vested with full responsibility and accountability for procurement spend, and a fragmented and balkanized buying arm that hinders synergy and unity of effort.

The Difficulty Leveraging Services in the DoD

The DoD spends significant amounts of its annual procurement spend on services. "Between 2001 and 2002, DoD's reported spending for services contracting jumped almost 18 percent to about \$93 billion" (GAO, 2003). In 2004, the DoD's spending on services approached \$100 billion annually (GAO, 2004). With services now accounting for more than half of the DoD's total annual spend, seeking leverage opportunities is appealing. Leveraging relates to the concept of economies of scale. Scale economies refer to economic efficiencies earned by carrying out a process on a larger and larger scale. Cost reductions come from the ability to distribute non-production costs over a greater number of products. In other words, as volume increases, organizations gain economic efficiencies by diffusing total input costs across a broader base. Ultimately, this decreases the marginal cost of producing the good or service. When an organization purchases in bulk, it achieves economies of scale by decreasing the average cost of inputs. Researchers have identified two segments of economies of scale: volume and learning (Pearson & Wisner, 1993).



Volume economies of scale refer to the definition provided above; namely, increases in production volume allow for lower unit costs. Organizations achieve learning economies of scale where improvements or advancements in labor and organizational efficiencies or improvements in planning or techniques lead to lower total costs and per-unit costs. People often refer to these gains as learning-curve efficiencies.

Centralization of labor in large-scale operations gives workers the opportunity to become proficient at the specific tasks assigned to them, and specialization further reduces labor inefficiencies. However, geographically distributed services, such as many of those required at DoD installations, may not allow for economies of scale because of the dispersion of labor. In fact, dispersion of services may actually increase average cost and result in dis-economies of scale. While this characteristic is not unique to the DoD, what is distinctive is the DoD's inability to replicate the private sector's response of possibly consolidating operations. For example, even where operational efficiencies are possible, base closings or mergers are controlled by Congress—not the DoD. Figure 3 displays the level of centralized purchasing for services by category (Center for Strategic Supply Research, 2002). Note the trend for the decentralization of distributed services. Whereas complex services (or those requiring retained relationships with the procuring organization) are often targets for centralization, non-complex distributed services such as food service, landscaping, janitorial, gate guards, waste removal or construction are not good candidates for centralization. These types of services are location-specific in that contractors must physically perform the services on the requiring installation. Also, distributed services are typically labor-intensive operations where labor costs comprise the majority of total contract costs. Typically, labor intensive operations are not amenable to economies-of-scale influences. This constraint may further offset potential learning economies of scale by inhibiting corporate learning. Lastly, services such as these are nearly impossible to centrally purchase effectively and efficiently because supply markets are highly localized. Consequently, they are simply not good candidates for centralized purchasing. Still, bulk purchasing of services could allow for some volume economies of scale by distributing fixed costs across a broader base.



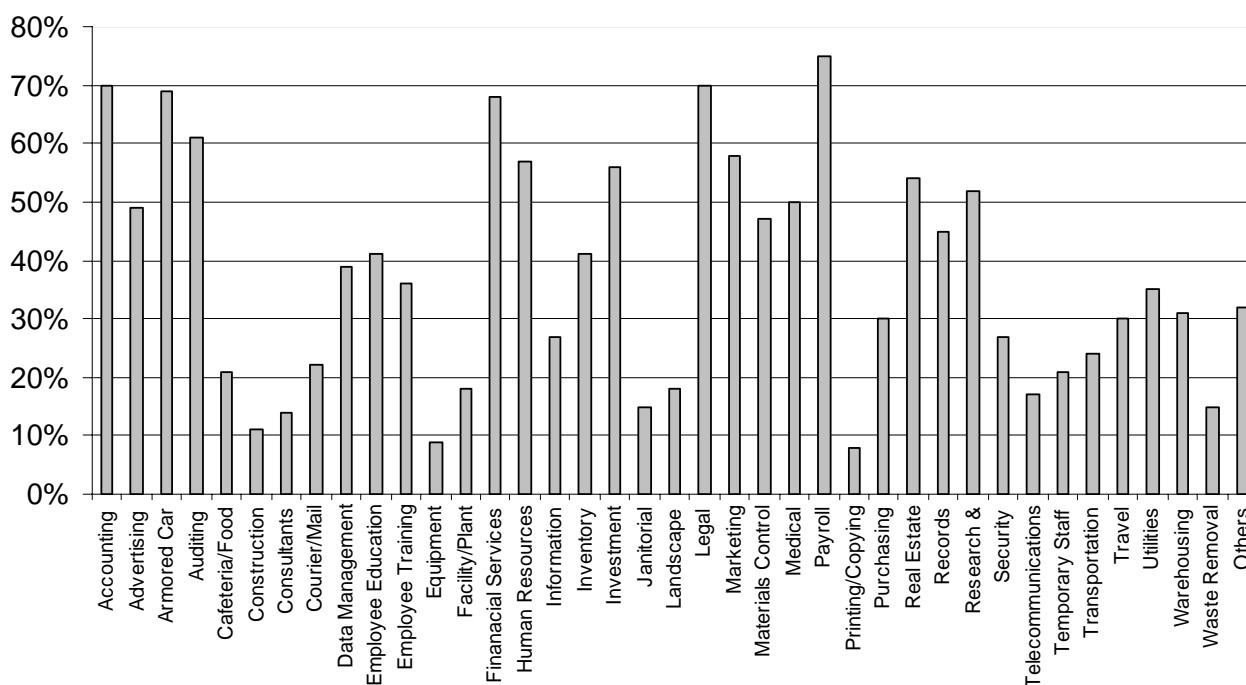


Figure 2. Centralized Purchasing of Services (Center for Strategic Supply Research, 2002).

The Effect of Federal Procurement Statutes on Leveraging Services

Statutes such as the McNamara-O'Hara Service Contract Act (SCA) of 1965 and the Davis-Bacon and Related Acts (DBRA) may actually inhibit volume economies of scale with respect to leveraging labor costs. In fiscal year 2003, federal agencies spent over \$45B on contract services covered by the SCA (GAO, 2005). The SCA applies to every contract "entered into by the United States or the District of Columbia where the principal purpose of the contract is to furnish services in the US through the use of 'service employees'" (Dept of Labor, 2006). The SCA does not apply to certain types of contractual services, but where applicable, it requires contractors and subcontractors performing on contracts in excess of \$2,500 to pay service employees no less than the wage rates and fringe benefits found prevailing in the locality. The Department of Labor determines the prevailing wage rates and fringe benefits in an area by the average of the wages and benefits earned by at least 50% of workers in a given service category and issues formal wage determinations which are incorporated into federal contracts.

Similarly, the DBRA "requires all contractors and subcontractors performing work on federal or District of Columbia construction contracts or federally assisted contracts in excess of \$2,000 to pay their laborers and mechanics no less [than] the prevailing wage rates and fringe benefits for corresponding classes of laborers and mechanics employed on similar projects in the area" (Dept of Labor, 2006). The requirement for contractors to pay their employees directed wage rates on federal contracts counteracts the establishment of market-determined rates. As a result, not only are labor costs not leveraged, but labor costs under SCA and DBRA provisions may actually be higher than those established in a

competitive marketplace. The Congressional Budget Office estimated that by repealing the SCA, the federal government could reduce the cost of procured services by approximately \$600M in 2000 and by about \$6.1B from 2000-2009 (CBO, 1999). Although the projected savings is difficult to measure, they argue repealing the act would promote greater competition among bidders and would allow contractors the flexibility to reduce the costs for providing services. Similarly, the CBO argued repealing the DBRA could help reduce costs by about \$245M in 2000 and by about \$9.6B from 2000-2009 using a similar rationale (CBO, 1999). Opponents argue repealing the acts could reduce the quality of services provided. Nevertheless, these laws interfere with competitive market forces and their effect on volume leveraging.

Additionally, contract administration for federal service contracts is labor intensive and could be exacerbated if geographically dispersed services were to be consolidated. In addition to location specific surveillances and quality evaluations required throughout the life of the contract, contracts under SCA or DBRA provisions often require annual wage determinations to address changing prevailing wage rates and benefits. Policymakers should consider the costs and burden of performing these administrative activities on consolidated contracts. In 2004, the Air Force attempted to consolidate gate guard services at 29 installations across the US. The two contracts had over 50 distinct wage determinations. The magnitude of the task required by the contracting office to manage the volume of determinations was burdensome in issuing the request for proposal alone, not to mention the administrative costs of addressing the annual wage determinations. While consolidating service contracts could lead to other value-added areas such as decreased transaction costs, timeliness, or other process efficiencies, these must be weighed against the increased administrative costs and burden.

Recall Kraljik's Strategic Sourcing Model wherein he recommended sourcing strategies based on the commodity's profit impact and supply risk. Leverage items, with their high profitability profiles and low supply risk, are the key targets for organizations seeking cost reductions. The DoD purchases a wide variety of commercial services for its installations and facilities. These include groundskeeping, janitorial services, security guard services, and information technology and communication services. These types of services are abundant in the market place and would be categorized as having a relatively low supply risk. However, the profitability potential for services is low as geographic dispersion and federal statutes diminish the cost reduction potential associated with the leveraged buying of services. Accordingly, perhaps such services should not be considered a leverage item in the DoD.

The Effect of the “Buy American Act” on Strategic Purchasing

The Buy American Act is another example of a statutory barrier to successfully implementing strategic sourcing. Congress codified the Act in 1933 with the express purpose of restricting the purchase of supplies that are not domestic end-products. The act seems to be rooted in the pre-World War II protectionist policies of the US. As implemented by FAR Subpart 25, the provision provides a preferential treatment for unmanufactured articles, manufactured goods and construction materials mined, produced or manufactured in the US. Regardless of its intent, the Buy American Act prevents the federal government from exercising strategic sourcing best practices as demonstrated by industry. In September 2005, Supply Chain Management Review identified five primary strategies that procurement leaders are adopting as part of their procurement transformation efforts. One of these strategies involves organizations adopting low-cost-country supply (LCCS)



initiatives. In efforts to reduce supply costs, companies are expected to double their spending with offshore suppliers by 2008 (Minihan, 2005). Savings can be dramatic with offshore manufacturing prices—as much as 30 to 50 percent less than those in the United States (Minihan, 2005). The Buy American Act expressly prohibits federal procurement organizations from accessing the same leveraging opportunities as industry.

The Effect of Federal Labor Laws and Small Business Goals on Strategic Purchasing

Industry's strategic sourcing successes hinged on leveraging principles which require consolidating enterprise-wide volume and concentrating the supply base. On average, leading procurement organizations operate with approximately 50% fewer suppliers and concentrate upwards of 80% of their purchasing on approximately 6% of their suppliers. These practices cause alarm amongst small business advocates in the United States. Table 2 lists the contributions of US small businesses as reported by the Small Business Administration.

Contributions of US Small Businesses	
	<ul style="list-style-type: none"> provide approximately 75 percent of the net new jobs added to the economy.
	<ul style="list-style-type: none"> represent 99.7 percent of all employers.
	<ul style="list-style-type: none"> employ 50.1 percent of the private work force.
	<ul style="list-style-type: none"> provide 40.9 percent of private sales in the country.
	<ul style="list-style-type: none"> account for 39.1 percent of jobs in high technology sectors in 2001.
	<ul style="list-style-type: none"> account for 52 percent of private-sector output in 1999.
	<ul style="list-style-type: none"> represent 97 percent of all US exporters

Table 2. Small Business Statistics (SBA, 2006)

The federal government recognizes the importance of small businesses to the economy, and actively promotes small business growth through advocacy programs, laws and regulations which incorporate small businesses in the federal acquisition process, specific goals for agencies in small business concerns, and reserving categories of federal procurements solely for small businesses. In March 2002, the President issued his Small Business Agenda. Citing small business as the backbone of the US economy, the agenda aims at creating an environment in which small businesses can flourish. This paper does not argue the merits of small businesses' contributions to the workforce, to the economy or to innovations or technology advancements. Rather, this paper addresses, in part, the dynamics of small business advocacy which serve as a barrier to successfully implementing strategic purchasing in the DoD.

Federal agencies have attempted to leverage buying power by consolidating and bundling contracts. According to Federal Acquisition Regulation, subpart 2.101, contract bundling means to consolidate:

two or more requirements for supplies or services, previously provided or performed under separate smaller contracts that were or could have been performed by small business, into a solicitation for a single contract that is likely to be unsuitable for award to a small business concern due to diversity, size, or specialized nature of the elements of performance specified; aggregate dollar value; geographic dispersion of contract performance sites; or any combination of these factors.

Contract consolidation refers to a similar approach with the exception that it pertains to all combinations of requirements that were previously performed separately by businesses of any size (large or small). Agencies bundle and consolidate contracts in order to leverage the government's buying power. The practices agree with strategic sourcing principles practiced by industry.

Unfortunately, the goals of consolidation and bundling are nearly polarized with the goals of small business development. In fact, in 2002, the OMB prepared a strategy for "unbundling" federal contracts. The strategy explicitly states a federal objective of not pursuing operational efficiencies at the expense of reducing small business opportunities (OMB, 2002). They argue that bundled contracts have reduced federal contracting opportunities for small businesses and that for every \$100 awarded on a bundled contract, there is a \$33 decrease to small businesses (OMB, 2002). As a result, bundling and consolidation efforts receive considerable opposition. The President's strategy focuses not just on unbundling contracts and avoiding future bundling but on actively seeking opportunities for small business awards. FAR 19.202-1 reinforces this small business emphasis by requiring federal contracting officers to divide proposed acquisitions of supplies and services into smaller lots (where applicable) in order to permit offers on quantities less than the total requirement and to plan acquisitions such that more than one small business concern may perform the work. The requirements to not only scale down purchase volume but to expand the number of suppliers and contracts awarded violate industry's strategic sourcing principles.

Not all public procurement activities yield to the small business rationale. In 2004, state procurement officials in Pennsylvania challenged the rationale of emphasizing small business to the detriment of operating efficiencies. While strategically sourcing office supplies, the state reduced its supplier base from over 1,800 separate vendors to one central supplier. The decision drew opposition from small business advocates who argued the economical impact of reducing small business opportunities. The state's general services director stated "purchasing didn't have a mandate from the voters to spend more money and buy more from more vendors. We had a mandate to reduce spending" (Patton, 2006). The state argued their responsibility was creating an environment wherein small businesses could flourish—not subsidizing them through directed contracts.

Another area that confuses the issue is the government's ambiguity in direction provided federal agencies in regards to procurement policy. In a May 2005 OMB memo sent to all federal agencies, Mr. Clay Johnson, the OMB Deputy Director for Management, directed agencies to leverage spending to the maximum extent possible using strategic sourcing methods. The direction requires agencies to identify at least three commodities that could be purchased more effectively and efficiently and requires agencies to set cost-



reduction goals. Also, in the same memo Mr. Clay directs agencies to increase achievement of socio-economic goals (small business goals) and improve vendor access to business opportunities. The guidance seems conflicting in that pure leveraging through strategic purchasing requires consolidating enterprise-wide volume and concentrating the supply base. How can a procurement organization simultaneously concentrate the supply base while increasing small business subcontracting goals and improving small business access to business opportunities? The new direction creates a paradox for federal buyers. Any compromise between leveraging objectives and small business objectives ultimately reduces the potential benefits of either approach.

No Single Voice in Federal Procurement

The DoD procurement system supports perhaps the largest and most complex organization in the world: operating out of 600,000 facilities at 6,700 locations in 146 countries. Out of this system, DoD contracting officers annually award nearly 9.3 million contracts.

The organization is really more of a conglomeration of individual organizations rather than one entity. The distinctive missions of these individual units mark them as distinct as separate companies operating in the commercial marketplace with each unit operating as a quasi profit-and-loss center. Responsibility and accountability for efficient procurement execution rests at the unit level. Thai (2001) described the procurement system as “nested structure of systems within systems” with a structure of “centralized procurement within the executive branch, and a complicated structure of decentralized procurement within executive agencies.” In order to provide adaptive, flexible and tailored procurement solutions for individual units, the system is fragmented and decentralized by design. As a by-product of this design, though, there is no single voice in the DoD responsible for the organization spend, or with the ability to dictate and enforce strategic acquisition programs. Additionally, the fragmented purchasing system limits the DoD’s efficiency and effectiveness.

Leading strategic sourcing experts cite two critical factors necessary to successfully implement strategic purchasing. First, they identify the need for top management to believe fully that centralized procurement is the best method to improve procurement effectiveness. Secondly, they identify the requirement to put in place a chief procurement officer charged with the responsibility and accountability for procurement operations (Richter, 2003; Porter, 2003). This individual should have authority over key procurement responsibilities—especially source selection and supplier performance decisions. Without this “single voice” with complete visibility, oversight, and profit and loss responsibilities, centralization efforts in the DoD will fail.

Air Force Commodity Councils rely on collaboration and consensus among team members chartered to coordinate on strategic purchases. Council chairmen lack the authority to require participation and enforce procurement policies and sourcing decisions. For example, in the recently established Force Protection Commodity Council, the Director for Air Force Security Forces (AF/XOF) and the Air Force’s Deputy Assistant (Contracting) (SAF/AQC) shared the responsibilities as the Commodity Sourcing Official and sanctioned the Commander of the Air Force’s Security Forces Center (HQ AFSC) to lead the Force Protection Commodity Council process (USAF, 2004). By design, the council senior leadership team (the CSO and HQ AFSFC) provided policy support in commodity process execution and program direction, oversaw strategy development and ensured execution and



reporting compliance. However, the Air Force failed to designate accountability for program success and failed to require enterprise-wide participation. In other words, buying organizations were never required to participate in the strategic purchasing efforts, and no one was held responsible for results. The charter tasked the major commands (MAJCOMS) to identify representatives to serve as subject-matter experts and to survey base-level functional areas for information on current usage and future requirements but never required MAJCOMS to centrally purchase commodities. This voluntary aspect of the process undermined the Air Force's need to consolidate enterprise-wide volume and sub-optimized the potential outcome by weakening the organization's leveraging power.

One only needs to follow the money trail to identify where the power ultimately rests. After Congress appropriates and apportions funding to federal agencies, the services then distribute funds through the major commands to individual organizations that then have the responsibility for funds obligation and execution. Procurement responsibility in the DoD resides at the unit level. In DoD strategic purchasing scenarios, units voluntarily agree to collaborate in the venture, but as the owners of the requirements and the funding, the decision to participate is theirs. Unfortunately, decentralized units are often reluctant to give up control of sourcing decisions and want to control everything that touches their business operations (Gerstner, 2002). The Councils then rely on the collective teamwork of multiple decentralized organizations and hope to achieve successful solutions. With this structure, it is nearly impossible to effectively leverage the organization's global buying power. Without a chief procurement officer with real power to affect all designated expenditures, strategic purchasing in the DoD will only be a titular initiative. With no single voice responsible for the acquisition process, it is incredibly difficult to implement strategic sourcing solutions.

The absence of a single voice also leads to confusion and ambiguity in regards to DoD actions and objectives. Industry objectives are clear. Leaders cite strategic purchasing as one of the first things a company should do to save money (Porter, 2003). By taking a corporate approach to procurement, they use strategic purchasing practices to optimize price, quality, delivery and technology, and they task procurement organizations to achieve demanding cost-reduction goals. DoD actions, on the other hand, seem disjointed and ambiguous. Congress and DoD leaders acknowledge the fiscal crisis, and as of 1 October 2005, the OMB requires federal agencies use strategic sourcing to lower costs and maximize the value of each dollar spent. The DoD, however, seems to be targeting the wrong areas. Rather than focusing on true leverage items with high returns, the Department's focus seems directed more on process control and transactional analysis in order to improve operating efficiencies. Some may argue dollars saved through improved operations (efficiency funds) could be used to fund other initiatives. Unfortunately, there is no method to budget, plan for and obligate for efficiency funds. Also, as efficiency funds relate to manpower costs, they do little to fund tangible requirements for goods and services. Improving operating efficiencies is a noble effort but only a small portion of the problem. The Department faces not just the problem of doing more with less but also getting more for less. The DoD must do more than reduce its operating costs (a transactional process approach)—it must reduce purchasing costs in order to survive the current budget shortfall (a strategic approach). Lastly, since quantifying efficiency savings is subjective and difficult to measure, procurement organizations may find it hard to “sell” the concept to senior leaders.



Conclusion

The DoD is struggling to survive a fiscal crisis. The Department faces rising operating and maintenance costs, necessary modernization costs, and higher personnel costs required for recruitment and retention, healthcare and other “must pay” bills. Since increasing the budget is not an alternative, the Department will have to transform its business processes. One alternative is to reduce the cost of business operations by increasing the efficiency with which current funding is used (doing more with less). Another alternative is to identify more innovative ways to operate. This is more than just trying to meet existing requirements more efficiently. Rather, it involves meeting existing requirements by operating in very different ways such as strategic purchasing (getting more for less). When faced with flat demand and a competitive market, leading organizations used strategic purchasing to drastically reduce purchasing costs. In many cases, organizations reduced purchasing costs by as much as 55% annually. They accomplished these savings using the two central tenets of strategic purchasing: 1) consolidating enterprise-wide volume, and 2) concentrating the supply base.

The DoD has barriers to successfully implementing strategic purchasing. These barriers are such that the Department’s potential cost reductions will pale in comparison to those achieved by industry. First, geographically distributed services required by the Department are not amenable to leverage principles. Furthermore, labor laws such as the Service Contract Act and the Davis-Bacon Act not only inhibit scale efficiencies but may also add costs. Secondly, the federal government’s emphasis on supporting small businesses requires the DoD to abandon the key tenets of strategic purchasing. Strategic purchasing and small business goals are polarized. The DoD can not simultaneously concentrate the supply base while increasing small business subcontracting goals and improving small business access to business opportunities. Therefore, any DoD procurement process will require a compromise between small business goals and cost reduction goals—which ultimately sub-optimizes outcomes for each. Finally, because of its requirement for decentralized operations, the DoD is unable to establish a chief procurement officer with the authority to effect all designated expenditures. Without that single voice, it will be incredibly difficult for the DoD to successfully implement strategic sourcing solutions, and the process will be perceived as titular.

We recommend the DoD readdress its strategic purchasing program. First, the DoD should reexamine its efforts of centralizing purchases for geographically distributed services. These types of commodities should not be considered a leverage item. They are not amenable to scale economies and the SCA and DBRA further inhibit potential cost savings. While commodity councils may achieve some process efficiencies through more timely ordering or by eliminating redundancies, the administrative costs may outweigh the benefits. We recommend the DoD target small businesses as prime candidates for providing these types of services. With contracted services now accounting for more than half of the DoD’s total annual spend, the potential for small business is enormous.

Second, although pressured by the OMB directive to engage in strategic purchasing, the DoD must proceed smartly. Before executing any strategic purchasing efforts, the Department must place a greater emphasis on quantifying potential savings. By developing cost savings models, the DoD can build a case for taking a consolidated approach, justify its actions, and allow senior managers to realign resources to more effectively support other mission priorities. In some cases, the DoD may find the associated administrative costs of strategic purchasing actions may outweigh the potential benefits. Therefore, efforts to



regionalize or centralize services procurement should be carefully scrutinized from a cost standpoint. The DoD faces a clear choice: drastically reduce costs, or drastically reduce its mission. Industry has shown us that strategic sourcing is a powerful tool for reducing cost. But just as a hammer is of little use to a rhinoceros, commodity councils are falling short of their potential impact in the hands of the DoD.

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Strategic Sourcing in the Public Sector

Presenter: Walter N. Quade, Commonwealth of Pennsylvania

Abstract

The purpose of this paper is to present a new approach to Public Sector Procurement Policies. In the past, the majority of Public Sector Procurement focused on the process issues surrounding the procurement rather than the objectives of Supply Chain Management as found in the private sector.

Pennsylvania, as a leader in implementing new approaches to Government, has lead the way in adapting those policies that have been proven effective in managing cost and the supply chain in the world business environment of the 21st Century.

Government entities have lagged the private sector models of adding value to the Supply Chain of their organizations. Often we hear of the overpriced goods and services that drive the cost of Government in an unprecedented upward spiral. With the recent slowing of economic growth and the accompanying tax base, and a higher demand for Government Services we find ourselves in new territory as a nation. Somehow we need to reevaluate how Government Business is conducted and the Value Added principal to effectively "Do more with less." People continue to question how to incorporate private sector practices into the public domain. Strategic Sourcing, as practiced in Pennsylvania, is the starting point for improving operational effectiveness of all levels of Government.

The presentation will focus on the planning and implementation of Strategic Sourcing in Pennsylvania and discuss the opportunities and challenges of implementing it in any Government Sector. The focus will be on developing tangible objectives for the Procurement Divisions and moving out of the "Way things have always been done" to one of "innovation and experimentation."

The final part of the presentation will define how to implement these practices in Government and discuss the necessary structure to support it.

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Panel – Implementing RFID in the Defense Supply Chain

Wednesday, May 17, 2006	Implementing RFID in the Defense Supply Chain
1:30 p.m. – 3:00 p.m.	<p>Chair:</p> <p>Alan Estevez – Assistant Deputy Under Secretary of Defense (Supply Chain Integration)</p> <p>Discussant:</p> <p>Tali Freed – California Polytechnic State University</p> <p>Papers:</p> <p><i>What Is the Right RFID for Your Process?</i></p> <p>Geraldo Ferrer, Naval Postgraduate School</p> <p>Uday Apte, Naval Postgraduate School</p> <p>Nicholas Dew, Naval Postgraduate School</p> <p><i>Investigating the Department of Defense's Implementation of Passive Radio Frequency Identification (RFID)</i></p> <p>LT Christopher A. Thomas, USN, COMNAVSURFOR</p> <p>Capt Emeterio V. Hernandez, USAF, AFLMA/LGLR</p>

Chair: Alan Estevez, Assistant Deputy Under Secretary of Defense (Supply Chain Integration)

Mr. Estevez is the Assistant Deputy Under Secretary of Defense (Supply Chain Integration) within the Office of the Deputy Under Secretary of Defense (Logistics and Materiel Readiness). He is responsible for development of global supply-chain management and distribution policies and processes to support the warfighters' operational requirements in the 21st Century. He assumed his current position and was inducted into the Senior Executive Service in October 2002.



Prior to assuming his current position, Mr. Estevez was the Deputy to the Assistant Deputy Under Secretary of Defense (Transportation Policy) from May 2000 to September 2002. In that capacity, he was responsible for development of policies in support of DoD strategic mobility, transportation, and traffic management programs. From September 2001 to December 2001, Mr. Estevez was the Acting Assistant Deputy Under Secretary of Defense (Transportation Policy).

Mr. Estevez was the Assistant for Traffic Management in the Office of the Assistant Deputy Under Secretary of Defense, Transportation Policy from December 1995 to May 2000. Mr. Estevez played critical roles in the Deputy Secretary of Defense initiative to reengineer Defense transportation documentation and payment processes, as well as in the development of the DoD Transportation Acquisition Policy and development of the DoD Logistics Automatic Identification Technology Implementation Plan.

From 1990 to 1995, Mr. Estevez was a logistics management specialist assigned to the US Army Strategic Logistics Agency where he managed the Army's program to correct logistics deficiencies identified during Operations Desert Shield/Desert Storm. From 1981 through 1990, Mr. Estevez held numerous positions with Military Traffic Management Command in Bayonne, New Jersey, Oakland, California, and Falls Church, Virginia.

Mr. Estevez received a Bachelor of Arts degree in Political Science from Rutgers University, New Brunswick, New Jersey in 1979 and a Master's degree in National Security Resource Strategy from the Industrial College of the Armed Forces in 1995. He is the recipient of the Office of the Secretary of Defense Medal for Exceptional Civilian Service and the Office of the Secretary of Defense Award for Excellence.



What Is the Right RFID for Your Process?

Presenter: Geraldo Ferrer is an Associate Professor of Operations Management at the Naval Postgraduate School. Prior to joining NPS, he was in the faculty of the Kenan-Flagler Business School at the [University of North Carolina](#) for seven years. His areas of expertise include global operations, supply-chain management, sustainable technologies, product stewardship, reverse logistics and remanufacturing. He has also studied the reverse logistics required in recycling and remanufacturing operations, and inventory problems affecting products made in small batches for frequent deliveries.

He has published on these topics in *European Management Journal*, *Management Science*, *Naval Research Logistics*, *IIE Transactions*, *Production and Operations Management*, *European Journal of Operational Research*, *International Journal of Production Economics*, *Ecological Economics*, *Business Horizons* and *Resources Conservation and Recycling*. He is a contributor in the *Handbook of Environmentally Conscious Manufacturing* and *Handbook of Industrial Ecology*.

He has presented his research in national and international conferences on four continents and in invited seminars in various academic institutions. Dr. Ferrer serves as reviewer in many academic journals and for the Social Sciences and Humanities Council of Canada. He has also reviewed textbooks in the areas of operations management, inventory management and project management. He has consulted for companies in the United States on waste reduction and reverse logistics issues.

He received his PhD in Technology Management from [INSEAD](#), his MBA from [Dartmouth College](#), a mechanical engineering degree from the [Military Institute of Engineering](#) in Rio de Janeiro and a BA in Business Administration from [Federal University of Rio de Janeiro](#).

Dr. Ferrer was founder and director of Superserv, Ltd., a company that promoted technology transfer ventures between North American and Brazilian business, introducing innovative technology products for the petroleum industry.

Uday Apte is Professor of Operations Management at the Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA. Before joining NPS, Apte taught at the Wharton School, University of Pennsylvania, Philadelphia, and at the Cox School of Business, Southern Methodist University, Dallas. He is experienced in teaching a range of operations management and management science courses in the Executive and Full-time MBA programs.

Areas of Apte's research interests include managing service operations, supply-chain management, technology management, and globalization of information-intensive services. He has published over 30 articles, five of which have won awards from professional societies. His research articles have been published in prestigious journals including *Management Science*, *Journal of Operations Management*, *Decision Sciences*, *IIE Transactions*, *Interfaces*, and *MIS Quarterly*. He has co-authored one book, *Manufacturing Automation* and has completed work on another co-authored book, *Managing in the Information Economy*.



Apte holds a PhD in Decision Sciences from the Wharton School, University of Pennsylvania. His earlier academic background includes a MBA from the Asian Institute of Management, Manila, Philippines, and a Bachelor of Technology degree from the Indian Institute of Technology, Bombay, India.

Prior to joining academia, Apte managed information technology and operations functions in the commercial banking, insurance and utility industries for over ten years. He has also consulted with several major US corporations and international organizations including IBM, Texas Instruments, Nokia, Kinko's, Nationwide Insurance, Nations Bank and The World Bank.

Nick Dew is an assistant professor in the Graduate School of Business and Public Policy at the Naval Postgraduate School, Monterey, CA. Dew has a PhD in Management from the University of Virginia, and a MBA from the Darden Business School, as well as a BA in history from the University of York in the UK. Before joining academia, Dew worked in strategic management and sales & marketing for British Petroleum, Europe's largest company, including a two-year assignment in BP headquarters and a three-year international assignment in Southeast Asia.

Dew joined the faculty at the Naval Postgraduate School in 2003 where he teaches strategic management in the MBA program. He researches the evolution of the RFID (radio frequency identification) industry and entrepreneurial decision making. His work has appeared in the *Journal of Evolutionary Economics*, the *Journal of Business Venturing*, the *International Journal of Entrepreneurship and Innovation* and the *Scandinavian Journal of Management*. For more information on entrepreneurial decision making, go to www.effectuation.org.

Abstract

Radio Frequency Identification (RFID) has several applications in both military and civilian organizations. Numerous configurations are possible, and multiple new applications are envisioned in the near future. This paper uses the case method to study several RFID applications in multiple industries and to evaluate how this technology can be used to strengthen the process capabilities of an organization. The goals of this paper are to introduce RFID technology to a manager that is contemplating its adoption and to introduce conceptual frameworks that a manager can use to select and justify the right technology configuration among multiple alternatives.

Keywords: RFID; Operations Strategy; Technology Management; RFID Case Studies

Executive Summary

Radio Frequency Identification (RFID) has several applications in both military and civilian organizations. Numerous configurations are possible, and multiple new applications are envisioned in the near future. This paper uses the case method to study several RFID applications in multiple industries and to evaluate how this technology can be used to strengthen the process capabilities of an organization. The goals of this paper are to introduce RFID technology to a manager that is contemplating its adoption and to introduce conceptual frameworks that a manager can use to select and justify the right technology configuration among multiple alternatives.



Introduction

The evolution and application of new technologies have always played a key role in improving the operational performance of production and delivery of goods and services. As a new technology is developed and its potential is proven, firms contemplate using it in processes and equipment that can generate value for their customers while improving their company's operational performance in terms of cost, quality, speed, flexibility and so forth. Many experts assert that Radio Frequency Identification (RFID) is a proven technology innovation that is being adopted by a wide range of organizations and is likely to have a significant impact on the field of operations management in the years to come (Lahiri, 2005; Fleisch & Tellkamp, 2005; Wyld, 2005).

The ability to identify things is one of the most basic, yet important, prerequisites to making and delivering goods and services. Consider, for example, an order fulfillment process. In this process, it is critical that the worker is able to identify and locate a specific item being ordered and then pack and ship it to the customer. As an automatic identification (or auto-ID) technology, RFID can help machines identify things such as physical objects, animals or customers and, consequently, dramatically simplify the operational processes. In addition, RFID technology has the ability to store and exchange large amounts of information about objects in the system. RFID technology can, therefore, be used as a sophisticated data-gathering platform to support and enhance the decision and control capabilities in computer-integrated manufacturing and service operations; that is the main attraction of this technological innovation.

Although the use of radio frequency to identify goods is not a new concept, only in recent years are firms starting to realize the true potential of RFID. Current applications provide benefits as varied as reduced cost and cycle-time, and improved process speed, dependability and quality assurance. For example, recent concerns with supply-chain efficiency at the US Department of Defense (DoD) and at major retailers such as Wal-Mart, Tesco and others has prompted these organizations to adopt RFID technology. Moreover, RFID's ability to individually identify items in the supply chain has made it possible for the government to use this technology as a powerful security tool in many settings—ranging from border protection to livestock control.

Currently, the RFID technology is evolving at a very fast pace, leaving room for speculation regarding the benefits that RFID investments may or may not provide. Meanwhile, managers continue to struggle with the decision to adopt this technology, trying to select the configuration that is most appropriate for their operational needs and that enhances their organization's operational performance. In planning for the introduction of RFID, a manager must deal with four major technology management issues (Cohen & Apte, 1997): selection, justification, implementation and coordination. In this paper, we primarily deal with the first two issues in technology management—selection and justification—that are critical for managers to understand when contemplating an investment in RFID technology.

First, the issue of technology *selection*: In adopting a new technology, a manager is confronted with a range of choices affecting the design of the operational processes and the competitive position of the products and services being produced and sold. A manager addresses such technology selection issues as: What are the choices? How should alternatives be evaluated? How should a choice be made? What are the criteria for selecting a technology? The design of RFID systems requires that numerous parameters



specifying the technology should be selected so as to provide suitable operational capabilities to the system.

The second major technology management issue is *justification*. Automation technologies require major investments of capital, attention and enthusiasm. Such investments must ultimately prove to be worthwhile in terms of their costs and benefits. In all firms, a justification process is required prior to investment in a technology, and an evaluation process is needed during and after its implementation. In technology justification, several issues confront the manager: How should the analyses in justifying a technology be applied? Are traditional financial criteria and analytical approaches relevant; do they serve as barriers to technology adoption, or is there a need to develop and use new analytical approaches?

To set the stage for addressing the issue of selection, we introduce the range of choices available in configuring the RFID system. We discuss a variety of tag types (passive, active or semi-passive), possible operating frequencies, and the types of readers. We also discuss alternate system architectures (such as closed and open networks) and how they affect the economics of the RFID investment. The discussion of technology choices is made at a level appropriate for an informed managerial decision.

To better understand the RFID configurations that have been used in practice in a wide range of situations, we discuss and analyze several current applications of RFID technology. Most of these applications have been studied using primary sources of information such as personal interviews with buyers and suppliers of RFID systems. In these case studies, we focus on the operational needs satisfied by RFID technology and on the benefits realized in terms of four major process capabilities of an operation: quality, speed, flexibility and cost. Finally, we build on the analysis of RFID applications and propose conceptual frameworks that managers can use to select the right configuration for their RFID systems.

Next, we deal with the issue of technology justification. The benefits and costs associated with RFID technology use are identified, and the challenges associated with estimating them are discussed. We then review the traditional justification tools, such as net-present value and payback period calculations, and conclude that the approach of real options is better suited for justifying RFID technology than traditional methods.

The paper is organized as follows: the next section discusses some of the research literature that is related to RFID adoption. Section III introduces salient features of RFID technology, in particular the differences and capabilities of different types of tags, readers, and network configurations. Section IV presents cases of RFID adoption, starting with civilian examples, followed by applications of special interest to the military forces. Sections V and VI, respectively, deal with technology selection and justification. The two sections present the results of our case analysis and the proposed conceptual frameworks that can help managers select and justify the right configuration for their RFID systems. Section VII concludes the paper with a summary of findings along with a brief discussion of the possible directions for future research.



Literature Review

RFID technology was developed over several decades, as reviewed in the works of Landt (2001), Lahiri (2005) and Dew (2006). There are several bodies of research that are particularly relevant to the adoption of RFID technology. The first focuses on the role played by organizational resources, skills, knowledge, capabilities and learning (Levitt et al., 1988; Nelson & Winter, 1982). The adoption of an innovation can require organizations to either currently possess or to implement complementary organizational skills and capabilities so they can take advantage of the innovation (Argote & Ingram, 2000). For example, just as the diffusion of typewriters depended on the diffusion of typing skills, the diffusion of manufacturing innovations depends on the availability of relevant skills among adopters (David, 1985; Szulanski, 1996). In such cases, payoffs to adoption of an innovation are organization-specific because they depend on each particular organization's skills and capabilities in utilizing the innovation. Yet, the relevant organizational skills are costly to acquire. One reason is that information and knowledge are "sticky," and, therefore, costly to transfer between organizations (Von Hippel, 1994). Another reason is that the transfer of knowledge within or between organizations is dependent on the absorptive capacity (i.e., stock of knowledge) already held by receivers (Cohen & Levinthal, 1989). The difficulties of acquiring the relevant knowledge are further moderated by causal ambiguity (Lippman & Rumelt, 1982; Szulanski & Winter, 2001) and arduous relationships between sources of knowledge and recipients (Szulanski, 1996). Because of the difficulties associated with the replication of relevant knowledge and the spreading of best practices, organizational capabilities can be the source of sustainable profits from adopting innovations (Barney, 1991; Argote & Ingram, 2000). In this context, early adopters of RFID technology have the opportunity to maintain competitive advantage *as long as the correct configuration is selected*, which makes this a crucial decision for many organizations.

Because RFID is a networked technology, its adoption is dependent upon externalities that are typical of communication technologies (Schilling 2002; Suarez 2005; Majumdar & Venkataraman, 1998). The value of products in this category increases with the installed base of users (Rohlf's, 1974). For example, owning the only telephone in a region is not very useful, but as the number of telephone users increases, owning a telephone becomes incrementally more valuable (Artle & Averous, 1973). Research shows that growth of the installed base and complementary product availability are critical drivers of subsequent adoption of a technology (Srinivasan, Lilien, & Rangaswamy, 2004; Gandal, Greenstein, & Salant, 1999). After a critical mass of adopters is reached, adoption accelerates. However, "lock-in" to a given technology may occur (Katz & Shapiro, 1985) resulting in what have been described as "winner-take-all" markets (Schilling, 1998 and 2002), i.e. the dominance of single technology, as we have observed with VHS (video cassette standard), Windows (PC operating system), iPod (portable music device) and UPC (barcode standard). This convergence to a single technology occasionally results in a corporate monopoly if early developers do not reach an agreement regarding a technology standard that is available to all. Hence, the diffusion and adoption of RFID will be greatly influenced by the success of standards in development by ISO and other major industry players.

Since Skinner's (1969) seminal article, researchers have developed increasingly complex and robust models of manufacturing strategy to fit within the broader domain of corporate strategy. Wheelwright (1978) identified the manufacturing performance criteria that are critical to contributing to corporate strategy: (cost) efficiency, dependability, quality, and flexibility, that later became known as the competitive capabilities in manufacturing.



Ferdows and De Meyer (1990) extended the competitive capability framework indicating the existence of an efficient competitive progression for acquiring these capabilities. They should be acquired in the following order: quality, flexibility, dependability (speed), and, finally, cost. To push the concepts of competitive capabilities further, Teece, Pisano, and Shuen (1997) developed a dynamic capabilities framework for firms facing rapid technological change and development. In such an environment, the firm's competitive advantage resides in speed and adaptability, or, simply speaking, a firm's competitive advantage is its ability to identify and implement new advantages within a rapidly changing competitive environment. New technologies, such as the use of radio frequency identification to manage critical processes, have the potential to provide such advantage, if appropriately implemented.

Radio Frequency Identification Technology

A manager typically counts on expert technical assistance to make detailed tactical decisions about investments in technology. However, decisions related to selection and configuration of technology such as RFID require significant investment and have a strategic impact on the organization. To ensure that the right RFID configuration is selected, the manager must be an informed and intelligent consumer of the technology. Hence, in this section, we introduce and discuss RFID technology from a managerial viewpoint.

RFID is a semiconductor-based technology that can be used to identify or track objects. In its most basic design, an RFID tag can be thought of as a wireless barcode. The system typically includes radio-emitting tags, readers, and a host computer with the appropriate software. A tag is attached to each object being tracked, and it emits a unique electromagnetic signature that is captured by the reader. The host computer processes the respective information as needed. The electromagnetic wave is usually in one of five ranges of the radio frequency spectrum: 125-134 kHz (LF: low frequency), 13.56 MHz (HF: high frequency), 315-433 MHz or 868-915 MHz (UHF: ultra-high frequency), 2.45 GHz or 5.8 GHz (MW: microwave). Individual systems operate at very specific frequencies which depend on allocations made by regional authorities (Lahiri, 2005). Table 3 provides more details regarding these radio frequency ranges, indicating in which media they are transparent or opaque, the typical read rate and the read distance afforded by the range.

Table 3. Applications and Characteristics of Each Tag Frequency

Band	Frequency	RF transparent materials	RF opaque materials	Antenna size	Read rate	Read distance
LF	125-134 kHz	Plastics, fabrics, oils, liquids, wood and some metals.	Dense materials (brick and metals).	Largest	Lowest	Shortest
HF	13.56 MHz			Large	Low	Short
UHF	315-433 MHz	Most plastics, fabrics, oils, paper, dry wood.	Dense materials, wet wood, mud or snow.	Small	High	Long
	868-915 MHz					
MW	2.45 GHz	Most plastics, fabrics, oils, paper.	Dense materials and liquids.	Smallest	Very High	Medium

The reader is a device used to collect the radio frequency signals emitted by the tags and to transfer that information to the network computer. Readers may be fixed or portable and always require an antenna. Selecting and positioning the antenna is a tough engineering task; one must ensure the items are not read more than once and all items are read when expected. A reader receives the individual signal as each tagged object comes within range. It then transmits the information collected to the host computer, which may store it in a database for further processing as needed. Depending on the complexity of the task and the desired reading range, the system may use “passive tags,” “active tags” or “semi-passive tags.” Each of these has different capabilities regarding the amount of information it can exchange and the distance it may be from the reader before communication takes place.

Passive Tags and Readers

Passive tags do not have their own source of energy. Instead, they get their power from the interrogation signal of the reader, which activates each tag for a moment in time when it emits its signature in a process called “modulated backscatter.” Passive tags exchange power and data with the reader. Read ranges and performance characteristics vary depending on several parameters. For instance, LF (low frequency) passive tags perform well around liquids but have the shortest range of all types of tags (often just a few inches). On the other hand, UHF (ultra-high frequency) tags are quickly read and have a longer range (12-20 feet), but the signal may be interrupted by liquids, metals and other dense media such as brick. In addition, passive tags are usually robust and can withstand significant wear and tear. Since they do not use a battery, designing a system where the tag remains functional for an indefinite period of time is conceivable. Moreover, passive tags vary significantly in terms of their memory capacity and read-write capabilities, ranging from simple identification tags to mobile databases containing item history information.

If the purpose of the tag is just identification (as in most supply-chain applications), then a simple passive tag may be used. This type of application would induce the production of very large lots of identical chips, differing just by their unique signature. Each chip would contain just the identification digits, and the reader would have very simple input-output capabilities. For the chip manufacturer, this would ensure economies of scale and significant cost reduction. Ultimately, the low-cost passive tag may be used as a direct substitute for the barcode. However, passive RFID presents a very significant disadvantage: microchips will always cost more than printed stickers (a barcode printed on the product’s label is virtually free!). Hence, passive tags may be more useful in applications where functions other than object signature are desired. These applications would use at least one of the major features that passive tags possess and barcodes do not:

- **Data capacity**—Tags can be developed with the ability to store long signatures, a useful feature if the organization intends to identify individual items and not just the product. This is particularly useful where lot identification or expiration dates need to be controlled, as is the case of pharmaceutical products and other perishable goods. Moreover, data encryption may be incorporated if the tag includes sensitive data about the item.
- **Signal ubiquity**—Since the data is read using radio frequency, there is no need for unobstructed line-of-sight between the reader and the tag. This capability reduces manual intervention and enables reading information from multiple items at the same time. Moreover, it enables a reader to access the individual tags in items inside



packages and cartons, reducing product handling in warehouses and other storage facilities.

- **Read speed**—Passive RFID readers can access hundreds of tags per second using algorithms that momentarily switch each tag on, read it, turn it off, and then move to the next tag. Since item identification and counting is often a time-consuming activity in inventory handling processes such as cross docking and shelving, fast read speed may remove bottlenecks in the supply chain.
- **Robustness**—Inside a simple plastic case, passive tags require no maintenance and may have practically unlimited life expectancy. This is an important feature if the tags are used to identify valuable (or sensitive) assets in the organization. If the tag is appropriately encased, it may last an indefinite amount of time in various environmental conditions, and it may be recycled multiple times.
- **Discreetness**—In some applications, miniature tags may be attached to the package or inserted in the host asset itself, which may be a particularly useful asset management tool. RFID have been used as a deterrent of cattle theft; a tag inserted in conspicuous areas of the animal will stay in it until the animal is processed in the abattoir.

Whenever an application justifies exploiting one or more of these capabilities, we expect that RFID technology will displace the time-tested barcode.

Active Tags and Readers

For some applications, users may require the ability to send and receive signals from greater distances or to perform functions that require an independent source of energy not available in the passive tag. When this happens, active RFID technologies may provide the solution.

In active RFID systems, the tags and readers exchange only data, not power. The tags incorporate batteries (which have a long life expectancy) as their sole source of energy. Because active tags do not need to scavenge power from a reader, active tag systems use low-power radio waves that generally create less interference with other wireless networks.

Another difference between active and passive systems is the reader-tag interrogation process: the most common active tag, a transmitter, continuously beacons its identity at regular periods (i.e., it remains “active” by sending out a repeated “ping” into the environment), which the reader receives once it comes within range. Battery consumption is an important concern for this type of tag, so it is carefully programmed to ping at time intervals compatible with the application’s needs.

To save battery life, an active tag may have a more efficient design in which it sleeps in the absence of a reader. This tag is a transponder; before the data exchange takes place, it periodically wakes up and pings to check if a reader is listening to it. A transponder may also be designed to remain dormant until a reader sends a signal to activate it. The signal may be encrypted for security reasons or to prevent the tag from being awakened by the “wrong” reader. Therefore, an active tag may remain silent for longer periods of time, saving battery or preventing detection from unwanted sensors—an important security feature.



Active tags sometimes have sensors and storage memory attached to them to record information collected, such as temperature, humidity, vibration, etc. Once the tag is within range, it reports sensor information back to the reader. As features are added, however, tags become physically large, and battery life is compromised. Hence, the manager has to select these features very carefully because they affect key variables that are in permanent trade-off: cost, robustness, longevity, and range. As the designer attempts to improve these variables, the remainder may be adversely affected. For example: to increase range, the designer may select a chip and antenna combination that is more costly, is more cumbersome (thus less robust), and draws more energy from the battery (reducing life expectancy.) To improve robustness, the designer may select stronger enclosure, with requisite increases in cost and form factor, and so forth. Hence, the designer of an RFID system must take a careful look at the needs of the organization to ensure that the tag capabilities balance the trade-offs effectively. In all, active tags are akin to dedicated computers, capable of exploiting many features. Their benefits include:

- Location flexibility—signal strength allows information exchange with the reader at great operating distance.
- Programmability—the tag may incorporate a variety of commands to collect targeted environmental information.

One particular type of active tag is the RTLS (real-time location system), which allows precise location of the asset fitted with the tag (Armanino, 2005). Sensors located in the perimeter of the operating area (indoor or outdoor) sense the tag and communicate the signal strength to a central computer that, by triangulation, calculates its precise location. This capability has been used extensively to individually locate assets within large facilities.

Semi-passive Tags and Readers

Semi-passive tags extend the functionality of passive tags by collecting information using sensors that operate even in the absence of a reader. Consequently, semi-passive tags require a battery. Usually, the sensors in semi-passive tags are used to collect environmental data such as temperature, pressure or humidity. However, other sensors might be installed to track usage patterns of the host asset. The tags are called semi-passive because, despite the battery to feed the sensors, they only transmit information by returning a modulated backscatter signal when activated by the reader as passive tags do, which gives them a similar range of operation. This design allows live monitoring of the environmental conditions in the proximity of a tag, without it spending battery energy to send the signal as active tags do. The amount of data that can be captured depends on its memory capacity, and its lifespan depends on how often it collects information from the surrounding environment and on how quickly the battery life is consumed. Applications using semi-passive tags take advantage of at least one feature that it delivers better than passive or active tags:

- Discreetness—Compact size allows incorporating the tag in the design of the host asset.
- Functionality—Sensors collect and report data on environmental status or usage pattern.
- Security—Tag only transmits identity when interrogated by a reader with suitable encryption.



- Cost effectiveness—Limited functionality allows extensive battery lives and low-cost design.

The choice of tag type is clarified further in Table 4, which allows a first level selection of the appropriate tag according to its strengths and capabilities.

Table 4. Strengths, Limitations and Capabilities of Each Tag Type

Tag type	Strengths	Limitations	Tag capabilities
Passive	Lowest cost, longest life. All frequencies.	ID only, short reading range	Inventory control, supply-chain management, theft deterrent
Semi-passive	Low cost, long life, few sensors. All frequencies.	Limited memory, battery-life dependent	Inventory control, remote control, environmental tracking
Active (general)	Multiple sensors, long memory, long reading range	Expensive, battery life dependent. UHF only.	Asset management and control
Active (RTLS)	Location capability, long memory, long reading range	Expensive, battery-life dependent, dedicated use. Microwave only.	Asset location

RFID Networks

A simple RFID network within a small organization may require a minimal number of readers. However, a large network involving multiple organizations, such as a supply chain, may require a large number of readers located in the premises of multiple organizations. Clearly, a simple RFID network confined within an organization does not have to adopt a universal standard, as long as all readers in the network can receive and interpret the signal emitted by the tags in the system. In practice, as the technology evolves, standards are created to indicate acceptable operating frequencies in all frequency bands such that users have the confidence of making the technology investment without the risk of being locked to a single supplier. Consequently, whether they are closed or open, new RFID networks are built around standardized frequencies and technologies.

The thread that keeps the network together is the *edge system*, which interfaces the readers with the host computer hardware and software. Its main responsibility is to collect the data from the reader and control its behavior. In addition, it filters duplicate reads from multiple readers, aggregates the data and sends it to the host computer. The host computer software interprets the data from the edge system and interfaces with the corporate ERP or another data management program where the data is finally processed (Lahiri, 2005).

An RFID network with closed architecture involves a single organization without the expectation to expand the network to additional players. Closed networks operate within the boundaries of an organization and may use proprietary encryption or data-management technologies. They have been used for many years in different applications, such as managing livestock, tracking work-in-process inventory, managing hospital patients and as theft deterrence. It is also used in general purpose entry-control devices (identification passes, keyless car entry) and automatic payment systems (pay-at-the pump gas stations, road tolls). These applications work well because they do not require open transmission of data or the use of complementary technology by multiple stakeholders.



An RFID network with open architecture adopts universal standards that enable the addition of new players in the network with minimal cost to the organization. The organizations in the open network may have different objectives, each using the data collected in different ways. For example, a seller may use the information to track lot number and delivery date, and a buyer may use the same information to track the expiration date of perishable merchandise.

The presence of technology standards is what characterizes the open network, and is the greatest challenge facing current RFID project designers. Open systems typically require technology standards so that different stakeholders can use compatible technology (i.e., tag and reader compatibility) and internalize network externalities without violating commercial contracts between member organizations and technology providers.

Case Studies of RFID Applications

The use of RFID technology in business applications is quite recent, and, hence, case research is an appropriate methodology to use in this context. This methodology lends itself well to early, exploratory investigations where the variables are still unknown and the phenomenon not well understood. As argued by Meredith (1998), an emergent phenomenon can be studied in its natural setting with case research, and a meaningful, relevant theory can be generated based on the understanding developed through observing actual practice.

When building theory from case studies, it is possible to select cases using alternate approaches of sampling or replication. (Eisenhardt, 1989; Voss et al., 2002; Yin, 1994). Since the goal of the research at hand is to develop managerial guidelines for choosing RFID technology, we selected the former approach to understand the technology systems used in a wide range of applications. We study 13 RFID cases in total. We conducted focused interviews with users and technology providers of 10 illustrative civilian and military applications to develop a better understanding of the nature of RFID technology. In addition, we collected public data on some of these cases and three other relevant cases to obtain a broader view of the technology's potential.

We coded the case data on a number of dimensions, identifying the operational needs and the performance metrics that were targeted for improvement (such as cost efficiency, quality assurance, cycle-time, etc.) in each application. This data was analyzed further in two steps. First, we tried to identify and then determine the correlation between the operational needs, the targeted performance metrics and the configuration adopted. Second, the qualitative case descriptions were reviewed to gain further insights into the choice of RFID system configuration.

In this section, we describe 13 RFID cases with different technology configurations according to the type of tag (active, semi-passive or passive) and the type of network architecture (closed or open). We should mention that to limit the length of this section, we have kept the descriptions of these cases very brief. However, further details on these RFID cases are available from the authors upon request.



Civilian Applications

Passive tag application: Toll tag

The use of RFID tagging for automated toll collection has a long history, dating back to the 1970s (Landt, 2001, 2002). One operational need addressed by RFID here is the need to identify a vehicle and its owner so that appropriate tolls can be charged. The Singapore government launched a novel tagging system in 1998 based on proprietary RFID technology in microwave band to ensure rapid reading of passing vehicles. The system applies tags to vehicles, and readers are installed onto gantries above the highway which identify the date and time when each vehicle passed through the checkpoints for appropriate charges.

While one economic driver of the RFID system in Singapore was the substitution of labor by electronics, another justification for the system was space constraints. As traffic volumes increase, toll road operators need more space for tollbooths, space that often is not physically available. RFID tagging raises the throughput of tollbooths and, therefore, reduces the number of booths required. This makes RFID-equipped toll roads very appropriate in Singapore, where space is limited and very expensive.

The key novelty in Singapore is the way traffic authorities use the system to set variable road prices depending on the time of day. Based on level of traffic congestion expected at a given time, the authorities change road prices up to three times a month in order to alleviate road congestion and lower the social costs of congestion. Based on their experience, Singapore traffic managers have fine-tuned road prices by reducing the number of instances and length of time punitive pricing is used to discourage travel.

Passive tag application: Livestock tag

Major beef exporting countries such as Australia, Brazil, Canada and the United Kingdom are significantly concerned with the risk of “mad cow” and/or foot-and-mouth disease, since outbreaks of these diseases have resulted in a halt of exports and forced decimation of the livestock populations in order to prevent the spread of these diseases across borders. An operational need addressed by a passive RFID tag is to identify individual cattle and trace their movement through the supply chain to the slaughter process. This makes it possible to identify with which other animals cattle might have been in contact with and, thereby, prevent the spread of contagious diseases within these countries’ borders.

Australia was the first country to introduce mandatory RFID tagging of all cattle, followed by Canada, which replaced its previous mandate to tag all cattle with barcodes. Similar mandates have been introduced or are in discussion in all major beef-production countries. The National Animal Identification System, currently under discussion in the US, would require tagging virtually all domestic animals raised for human consumption to ensure the identification of the premise that is the most likely source of a contagion within 48 hours (Wyld, 2005). A cattle-control network usually requires individual tagging and the control of entry or exit points in corrals, abattoirs, exhibitions or other locales where the animals might commingle. Low frequency tags must be used because they are the least affected by mud, snow and humidity. However, given the short reading distance, handheld readers are required, which makes the reading process less effective. Accessory benefits of cattle tagging include tracking stock flow in the supply chain and improving stock quality by managing the heredity of prized animals (*RFID Journal*, 2005).



Passive tag application: Railcar tag

For many decades, US railroads have had difficulty dealing with the competition from long haul trucking, which was deregulated in 1980 and thereafter showed significant service improvements. By comparison, railroad service was poor. One observer explains, “They’d lose railroad cars or whole trains” (Landt, 2002). To effectively compete with the trucking industry, the railroads found it essential to identify and locate a railcar to know how it was moving through the system, and to link each railcar with its contents to have access to real-time product and tracking information. To help monitor the location of railcars, the Association of American Railroads implemented RFID technology across North America using 3,000 readers to track 1.5 million railcars and locomotives. The railroad companies agreed on a common standard for the technology and included data-sharing arrangements as part of the implementation.

Benefits of the system included service improvement and cost reductions. For instance, Burlington Northern Santa Fe Corp. eliminated 500 clerks who previously recorded railcar movements manually in a system that was prone to human error. The RFID system reduced these errors, which further reduced costs while improving the service reliability to railroad customers.

Some railroads have expanded the system to include semi-passive RFID tags that monitor critical functions of the locomotive operations, notifying potential breakdown or mechanical emergencies to repair crews, which are ready and waiting for the locomotive by the trackside when it needs repairs. This reduces costs by enabling planned maintenance and minimizing downtime and improves service by reducing unplanned delays.

Semi-passive tag application: Smart tires

Semi-passive RFID tags used for tire management allow tire leasers to identify individual tires and monitor tire operating conditions such as distance run, pressure and temperature at regular intervals. The tags operate in LF to avoid interference from the tire rubber. They have unique IDs, as well as real-time and historical data about the operating history of tires, including:

- Distance run—This helps fleet managers schedule planned maintenance in order to ensure maximum tire life. For the tire owner, this helps the enforcement of tire-leasing contracts.
- Tire pressure—When a tractor-trailer rig rolls into its depot, the tags in each of the 18 tires send information about the tires to a reader located at the entrance of the lot, including data on the internal tires, which are not easily accessible. Fleets with tire maintenance programs manually check the air pressure on every tire about once a week (which manually would take 20 minutes per rig). RFID technology substitutes manual checking, which speeds the process and saves labor.
- Tire temperature—This allows monitoring usage to prevent suboptimal conditions. Hence, it enables lower lifetime tire costs by ensuring that a higher percentage of tires are suitable for retreading. Also, given temperature history, a retreader is able to identify the most appropriate tread for a given casing.



Consequently, smart tires bring a number of benefits to vehicle fleet operators and tire owners. They are easier to manage since RFID helps in the development of fair tire leasing contracts with efficient consumption measures, keeping track of the distance run for correct invoicing. This data tracking reduces the conflicts between supplier and buyer by ensuring that the tires operate at proper parameters.

Semi-passive tag application: Refrigerated trailer tag

Sysco, the largest distributor of temperature-controlled food, is testing a system to identify, locate and track individual trailers as they move through the supply chain, and to monitor and record at regular intervals the temperature conditions inside refrigerated trailers. Upon delivery, the tags are handed to the customer, who can then interrogate them to inspect the temperature log before accepting the shipment (Gilbert, 2005).

The system uses open, standard, EPC-compatible tags so that different players in the supply chain can access the information collected. Because these semi-passive tags use low-power backscatter technology (the same as passive tags), battery life is longer and tag cost is lower than if the tag were active. In addition, the tags are reusable, which reduces the system's operating cost.

There are two key justifications for using this type of tag in the supply chain. First, temperature monitoring supports quality by assuring the customer that the goods were kept at the correct temperature through the supply chain. Ultimately, this also saves costs by providing the ability to detect which party was responsible for losses; this, in turn, reduces the costs of moral hazard and reduces insurance premiums. Second, this type of monitoring ensures the security of product in the supply chain by creating a custody chain that decreases the opportunity for theft or tampering (for instance, by terrorists who might seek to contaminate the food chain).

Active tag application: Vehicle tag in auto assembly plant

According to some market surveys, the automotive industry is the world's largest user of RFID by value, with purchases of \$600 million a year (which amounts to half of the RFID market). Automakers have pioneered the use of an RTLS (real-time location system) which uses multiple RFID readers in different locations to triangulate the exact position of active RFID tags. Two applications stand out: locating finished cars in parking lots and managing inventory levels of components used on assembly lines.

In some assembly lines, individual vehicles are identified and tracked as they progress through the assembly line and are placed in parking lots. A reusable active tag is hung on the windshield mirror with information about the vehicle, including the vehicle identification number (VIN). Once the vehicle is complete, it is parked in a lot until shipped to the dealer. Until recently, locating an individual car in the lot required a lengthy search. RTLS allows staff to quickly find individual cars by matching the VIN with the tag in a database, and using RTLS to triangulate the exact location of the tag. The tags are removed once the car is shipped to the dealer, and used again in another vehicle.

The same plant may use RTLS for other applications. RTLS tags fitted with alert buttons are used on component bins on the assembly line. They are manually activated whenever component inventory hits the reorder point, and then matched with information in a database prompting reorder and delivery of components to the exact location required.



This system has lowered the risk of shortage and allowed inventory reduction, facilitating the execution of JIT management.

Active tag application: Smart and Secure Tradelanes (SST)

Container monitoring is considered a major security issue in many countries. The US Homeland Security Agency introduced the Smart and Secure Tradelanes initiative (SST) with the objective of identifying each container, including its contents, and securing cargo containers at their point of origin using special RFID tags that, once sealed, could not be opened in transit without damaging the tag. This reduces security risks by ensuring the integrity of ocean-going containers between their outbound ports and their destination ports in the US.

The SST initiative has led the International Organization for Standardization (ISO) to approve the standard ISO 18000-7, which selected the frequency for tags in ocean-going containers. The US Federal Communications Commission (FCC) and China's State Radio Regulatory Commission (SRRC) have supported this frequency band for active RFID tags in security seals for containers—a critical step for establishing seamless cross-border shipments and for encouraging other countries to adopt the same standard.

Several of the world's major ports have already built RFID networks for container tracking. (Ironically, US ports lag far behind in adopting this technology.) The port of Antwerp, the largest in the world, uses RFID to monitor all containers within its premises to ensure proper handling of containers with perishables and to maintain their security, while the port of Singapore now uses RFID seals on all containers bound for US seaports.

Military Applications

Passive tag application: Soldier dog tag

US soldiers have been wearing “dog tags” around their necks since World War I. Recently, the Office of Naval Research developed smart dog tags that carry more information than just name and rank. The dog tags are used by rescue personnel to identify a wounded soldier, access medical history, provide custom medical care and keep a record of treatment given for future use. These tags carry a variety of data (such as age, allergies, blood type, medical history and immediate treatment records) that improves the chances medics give the right treatment to an injured soldier. Signal ubiquity is another advantage of smart tags because they can be read through military clothing such as chemical and biological suits, body armor vests and field jackets (Gilbert, 2002; Williams, 2005).

Conventional triage uses a paper tag system, in which tags can be soiled or misplaced. Using smart tags, medics may be able to provide faster and more efficient treatment to injured soldiers. After treating an injured soldier on the battlefield, a medic can use a handheld reader to write information to that individual's dog tag indicating the type of medical care the soldier received. Medics in the hospital would know the treatment provided in the field, expediting the prioritization of casualties. Estimates using trial data indicate that smart dog tags may reduce field losses by 30%. Because time is the enemy of critically injured personnel, this triage speed can increase a soldier's chances of surviving injury.



Passive tag application: Standardized supply-chain tag

Alongside the initiatives led by Wal-Mart and other major retailers, as well as the initiatives in the pharmaceutical industry driven by the US Food and Drug Administration, the US Department of Defense (DoD) has supported the Electronic Product Code (EPC) architecture for a globally open RFID system using passive tags. The main application of this network configuration is supply-chain management, replacing the use of barcodes. The operational need here is to identify each item in a container and to create an updated shipment manifest to improve information flow in the supply chains.

The Navy's Fleet Industrial Supply Center (FISC) in Norfolk, Virginia, implemented a passive RFID inventory control in November 2003. The site receives less-than-container-load shipments from military depots, shippers and vendors from all over the US and consolidates these into oceangoing 20- and 40-foot containers for export. In the past, manual processes generated shipping errors, so the site implemented the RFID-based system to improve shipping accuracy. Goods are tagged and read as they pass into a container, while the system generates a shipping manifest. The manifest is electronically written to an active tag attached to the container's lock.

Justification for the new system comes from fewer errors, faster loading times and reduced labor requirements. The combination of passive tags (for individual item shipment) with active tags (to track whole containers) enhances total inventory visibility within the Department of Defense, which improves military capabilities (Estevez & Geary, 2004).

Semi-passive tag application: Night-vision goggles

The ability to deny enemy's access to critical technologies is a military priority. Night vision technology is regarded as a major tactical advantage in the military community, giving the troops the ability to control the night. In recent years, the design of night-vision goggles has incorporated RFID tags so as to identify and locate an individual goggle to allow recovery if lost, and to deactivate the goggle if it can't be recovered to prevent it being used by the enemy. The semi-passive tag used in night-vision goggles works through the same "backscatter" principle as in passive tags, as mentioned above. But, it contains a battery that powers the microchip, thus relaxing the need for high-powered readers. The battery provides greater signal strength, extending the tag's range, which makes the goggles easier to locate. The readers have also been improved, both in read range and in their ability to locate each goggle tri-dimensionally within a few inches.

The other important functionality provided by the tag is the ability to remotely deactivate it, if it cannot be retrieved. If the approximate location is known, but the goggle cannot be located or it is unsafe to retrieve it, it may be remotely deactivated by a helicopter flying above the area to prevent the enemy's access to its capabilities (Gilbert, 2002).

Semi-passive tag application: Food ration (MRE) tag

Before Sysco started trials of semi-passive temperature-sensing RFID tags, the US Army identified a need for such devices to monitor its combat feeding program. The army found that MREs (meals ready-to-eat) were significantly affected by the extreme temperature conditions encountered in Iraq during Operation Desert Storm. The three-year shelf life of rations stored at 80°F was cut to six months at 100°F and down to just one month at 102°F. This created an operational need to identify individual MRE pallets and to record temperature at regular intervals to assess the remaining shelf life of each MRE pallet.



Because of the temperature-induced deterioration of MREs, the Army combat feeding program decided on a large-scale test program using open standard EPC-compliant semi-passive tags with temperature sensors on each pallet of MREs at its San Joaquin, CA, distribution center. The idea of the program was to sense temperatures and to use a shelf-life model to predict the anticipated remaining life of rations to ensure that MREs sent to troops in operating areas are used before their shelf life expires.

A computer-generated shelf-life model based on the temperature data collected by the RFID tags was incorporated in the program. The model analyzes the data and produces an estimate of the remaining shelf life for the MREs, giving each pallet of MREs its status: a green light means they are ready to go; a red light means they have exceeded their shelf life; and a yellow light indicates the need for more detailed inspection to determine their condition (Gilbert, 2005; Hernandez & Thomas, 2005).

Active tag application: Job shop tag

Tobyhanna Army Depot, Pennsylvania, recently adopted a RTLS system using active tags to identify, locate and track components for a more efficient re-assembly system in its radar remanufacturing process. Upon receipt, each radar system is disassembled, and its components are distributed to several different job shops where they are serviced before reassembly and testing. The RTLS system prevents items from being lost in the shop, reducing total cycle-time of the refurbishment process, reducing labor costs associated with manually tracking and finding parts, and lowering total inventory costs. The system automatically generates email alerts if items dwell too long in any workstation, and the long read-range of the active tags enables tagged items to be found in any location in the plant. This set of capabilities is quite useful in this shop where nearly all orders are made of unique jobs in a cluttered environment, making the queues in each station very hard to manage. Active tags are proactive in transmitting their data, so it keeps assets visible to personnel who manage the overall remanufacturing process even though these assets are distributed across different physical locations. This enables the reassembly process to be more efficiently managed.

An independent study of Tobyhanna estimated that the payback of the initial investment was less than one year, based on labor savings alone. The RTLS system also reduced cycle-time by 10 to 35 days, which increases radar uptime and, therefore, improves defense capabilities.

Active tag application: Total Asset Visibility (TAV)

The DoD first became interested in RFID technology for supply-chain applications during the first Gulf War. At supply depots in Saudi Arabia and Bahrain, logistics staff had to manually inspect arriving containers for their contents. It is estimated that 25,000 out of 40,000 containers were never inspected, resulting in \$2.7 billion dollars of unused goods sitting at depots for months or years after the war ended. To prevent similar problems in the future, the DoD introduced its ITV (In-transit Visibility) program in 1993 to increase the visibility of shipments. In July 2002, the DoD issued a directive to tag all air pallets and containers with active RFID tags. The idea was to identify each container, including its contents, and to locate and track containers as they move from factory to frontline and back.

The DoD's ITV network has grown into the largest active RFID-enabled cargo tracking system in the world, with over 800 reading stations in 45 countries, providing



information about equipment and cargo in 25,000 containers that pass through air, sea and rail terminals each day (Verma, 2005).

Using this system, the US Army estimated a 30% reduction in logistics assets required for the humanitarian operations in Somalia and Bosnia. The UK military, which also uses the system, estimated it achieved a 7% reduction in total logistics costs during Operation Iraqi Freedom. Other justifications for using the system include the ability to locate goods anywhere in the network (for instance, for expediting) and a reduction in the “bullwhip” effect occurring as a result of over-ordering. ITV has also been adopted as the standard for container tracking by NATO, Israel and Australia.

Selection of RFID Technology

In this section, we analyze the RFID cases described earlier. The approach we follow in this analysis rests on a simple premise that the choice of technology configuration is dictated by the operational needs in a business situation. Thus, in each case we first identify the operational needs and the choice of technology configuration. Next, we assess in a qualitative manner the correlation between these two to develop a better understanding of how RFID technology is chosen in practice. Finally, we propose conceptual frameworks in the form of a set of rules that managers can use to select the appropriate RFID technology configuration.

Table 5. Classification of Case Studies Based on the Choice of Technology Configuration

Range	Passive	Semi-passive	Active
LF	<i>Livestock tag (Open)</i>	<i>Smart tires (Closed)</i>	
HF	<i>Soldier Dog tag (Closed)</i>		
UHF	<i>Railcar tag (Open)</i> <i>Standardized supply-chain tag (Open)</i>		<i>Smart and Secure Tradelanes (Open)</i> <i>Total Asset Visibility (Open)</i>
Microwave	<i>Toll tag (Closed)</i>	<i>Night-vision goggles (Closed)</i> <i>Refrigerated trailer tag (Open)</i> <i>Food ration (MRE) tag (Open)</i>	<i>Vehicle tag (Closed)</i> <i>Job shop tag (Closed)</i>

As a starting point in analyzing these cases, we identified the technology configuration used in each case. Table 5 classifies each case study in two dimensions of RFID technology configuration: tag type (active, passive or semi-passive) and frequency range (LF, HF, UHF or microwave). It also indicates the choice of network architecture (open or closed) for each case. We notice that not all cells in the table are utilized. Because of the recent penetration of the Electronic Product Code (EPC) standard, certain frequencies have become more popular.

To develop a generally applicable set of operational needs, we analyzed all cases and identified specific operational needs satisfied by RFID technology in each case.



Thereafter, through a process of trial and error, we finally arrived at a super-set consisting of seven generic operational needs:

Read distance—distance between reader and tag. For the purposes of this paper, we define short distance as less than 10 feet, medium as 10-30 feet, and long range as anything over 30 feet.

Read rate—number of tags that can be read per time unit, or, how fast a tag can be detected by a reader and information be exchanged. RFID varies in its read-speed; this primarily depends on the frequency in which the tag operates.

Real-time asset location—need to identify a tag's precise physical location. For the purposes of this paper, we define "precise" location as within less than five feet in a two-dimensional space.

Process security—need to prevent third party access to signal. RFID tags are typically "promiscuous": active tags periodically broadcast a signal, and passive tags will typically broadcast to any reader that interrogates them. Therefore, users need to select tags that fit their security needs. For example, to protect tag information, one may choose tag encryption or proprietary identification systems.

Single- or multi-party access to information—number of organizations needing access to tag information. Single-party systems can use any manufacturer's RFID technology because there is no requirement for interoperability with other parties. Multi-party systems need tags that all parties in the system can access with high levels of interoperability. These systems, therefore, require a commonly accepted set of standards for tags.

Information richness—amount of data transmitted by tag. Tags vary enormously in the amount and type of data that they can store. For the purposes of this paper, we define low levels of information richness as "license plate" tags that only exchange an identification number (some cases we observed had tags that stored 12, 23, 96, 110 or 128 bits of data). We define high information richness as tags with many kilobytes of memory (for example, ocean-going container tags with 128 Kbytes of memory). Medium levels of information richness involve smaller amounts of memory (for example, sensor tags with 4 Kbytes of memory).

Medium of concern (transmission hurdle)—physical hurdles that interfere with data transmission between the tag and reader. This includes interference by fluids (water, mud, snow or oils), solids (rubber, plastic, glass and even animal flesh), and packaging materials (metal cans or wood pallets). Finally, the walls and equipment in the surrounding environment may interfere with the transmission.

Having identified the operational needs and the choice of technology configuration for each RFID case, we captured this data in a comprehensive manner in Table 6.



Table 6. RFID Applications—Operational Requirements and Technology Choice

Applications		Minimum Requirements							Choice of RFID		
Case	Case Type	Read distance	Read rate	Real-time location	Process security	Single or multi access to information	Information richness	Medium of concern (transmission hurdle)	Network Type	Tag Type	Frequency
<i>Toll tag</i>	CIV	Med	Very High	No	Low	Single	Low	none	Closed	Passive	MW
<i>Livestock tag</i>	CIV	Short	Low	No	Low	Multi	Low	Plastic, flesh, mud and snow	Open	Passive	LF
<i>Railcar tag</i>	CIV	Med	High	No	Low	Multi	Low	none	Open	Passive	UHF
<i>Soldier dog tag</i>	MIL	Short	Low	No	High	Single	Med	Plastics, fabrics and fluids	Closed	Passive	HF
<i>Standardized supply-chain tag</i>	MIL	Med	High	No	Med	Multi	Low	none	Open	Passive	UHF
<i>Smart tire</i>	CIV	Short	Low	No	Low	Single	Med	Rubber	Closed	Semi-passive	LF
<i>Refrigerated trailer tag</i>	CIV	Med	High	No	Low	Multi	Med	none	Open	Semi-passive	MW
<i>Night-vision goggles</i>	MIL	Med	Very High	No	High	Single	Med	none	Closed	Semi-passive	MW
<i>Food ration (MRE) tag</i>	MIL	Med	High	No	Low	Multi	Med	none	Open	Semi-passive	MW
<i>Vehicle tag</i>	CIV	Long	Very High	Yes	Low	Single	Low	Glass	Closed	Active	MW
<i>Smart and Secure Tradelanes (SST)</i>	CIV	Long	High	No	High	Multi	High	none	Open	Active	UHF
<i>Job shop tag</i>	MIL	Long	Very High	Yes	Low	Single	Low	none	Closed	Active	MW
<i>Total Asset Visibility (TAV)</i>	MIL	Long	High	No	High	Multi	High	none	Open	Active	UHF

The purpose of developing Table 4, as mentioned earlier, was to develop a better understanding of how RFID technology is being chosen in practice. Hence, the minimum requirements lead to the choice of technology configuration discussed below.

For many applications, *read distance* is a critical variable in the choice of RFID. For instance, supply-chain applications often need to read all materials as they cross the dock gate, which means read distances must be sufficient to cover the area of the gate (usually around 12 feet). In other applications, read distance is less important than other factors. For instance, subdermal implants are frequently used in animal tagging, but these only need

to be read at a few inches by an operator using a handheld reader. Read-distance requirements can dictate the use of active tags, which far outperform passive tags on this metric.

One case we studied demonstrates the need for high *read rate* better than any other: toll road tags in Singapore. The need here was for a system that could read a tag on high-speed vehicles as they pass toll stations. Because of the small amount of time that the tag is in the vicinity of the reader, this requires a very fast read-speed in order to be assured that the tag is successfully read. This dictated the use of microwave RFID because of its superior read-speed performance (all other things being equal). By comparison, tags read one-at-a-time using a handheld reader (for instance, soldier dog tags) have a relatively low requirement for read speed. In applications where the user needs sensor data (such as temperature information), read speed again becomes an important metric governing tag selection.

We studied several applications that demonstrate the need for *real-time asset location*. In automakers' vehicle parks, the chief requirement is the ability to accurately locate individual vehicles in order to reduce the time workers spend searching the parking lot. Similar advantages accrued in the remanufacturing job-shop application we studied, where the ability of managers to monitor the exact location of parts in a job shop (and, hence, expedite them) was critical to improving the efficiency of the final reassembly process. However, in many other applications, location precision is not required. In some applications, reader location acts as a surrogate for tag location, e.g., the standardized supply-chain tag is usually sufficient to know that a tag is in the vicinity of a reader in a given facility. In yet other applications, if the tagging is manual, location is implicit information, e.g., livestock tags.

Of the cases we studied, military applications best illustrate the need for *process security* (i.e., securing tags to outside investigation). This need led technology developers to create encryption techniques for passive tags, which require a reader to write a secret code to a tag before the tag will respond. Security is also an important variable in the SST (Safe and Secure Tradelanes) initiative, where active tags with a variety of sensors are used to ensure that unauthorized personnel do not tamper with oceangoing containers. Even in domestic supply-chain applications, managers may have reasons for securing standard supply-chain tags with encryption mechanisms in order to stop unauthorized parties from gaining access to detailed information about the movement of goods; this can be important for securing high-value items such as vaccines or electronic goods.

Of the cases we studied, railcar tagging represents a significant example of a *multi-party* RFID system (it is our understanding that this was the first major example of a multi-party system that was actually implemented). Because railcars travel on tracks owned by many parties, an infrastructure of multi-party RFID readers was required. Furthermore, these multiple parties also needed to share information about the location of individual railcars among them. In this case, the fact that the railroad industry had a pre-existing and strong industry association was critical in sponsoring the implementation of this multi-party initiative to adopt a standard RFID technology. Many other applications are *single party*. For example, toll tags are typically single-party systems, as are many manufacturing applications of RFID.

Information richness is often a critical variable in tag choice. For instance, in the TAV initiative, oceangoing containers are used as mobile warehouses for inventory.



Therefore, the tag on the container needs a high memory capacity so operators can read a container in a yard and know the inventory inside without having to open the container and manually account for its contents. Similarly, sensor tags involve rich information exchange. This requirement dictates the use of semi-passive tags with enough memory to accumulate temperature readings for a period of time, for instance, in applications in refrigerated trailers. In other applications, information exchange is limited to a unique identification number, such as toll tags, livestock tags or standardized supply-chain tags.

Medium of concern (i.e., transmission hurdle) often dictates what type of RFID is able to exchange data with its reader given the operating surroundings. For instance, as a minimum requirement, medical personnel need a soldier dog tag that can be read even when it is covered with fluids such as blood. It is also an advantage that the tag can be read easily through a secure plastic casing and through clothing materials. Tires and livestock applications are other examples where the media may affect tag performance. LF and HF tags often perform better in these restrictive environments. In still other applications, the medium is irrelevant. For instance, toll tags are often placed on vehicle license plates, and railcar tags are placed on the side of the car—locations that ensure there is nothing except air between the tag and reader. In these applications, passive UHF and microwave tags can be selected. All other things being equal, active tags often make a better choice where various mediums interfere with the transmission of RFID signals since they can beacon a stronger signal that often travels farther within various media.

It is important to realize that some of these requirements must be strictly met with a specific type of tag. For example, if the operating medium is opaque to UHF and microwave, then LF or HF must be used; otherwise, the reader cannot communicate with the tag. Other requirements may be satisfied with tags that exceed the operational needs, or using a technical solution that enhances the performance of the selected technology. The manager should make the selection recognizing the limits imposed by technical feasibility and operational needs.

Justification of RFID Technology

Automation technologies require major investments of capital, attention and enthusiasm. Hence, the manager needs to acquire significant buy-in in order to obtain the support necessary to undertake these investments. This buy-in requires, among other things, a solid justification that can be measured in terms of financial or operational benefits and the investment and operating costs associated with the technology.

Financial and Operational Benefits of RFID

In general, RFID technologies are adopted because they are an economical approach to satisfy an operational need and gain competitive advantage. In a civilian environment, the payoff is usually characterized in terms of increased revenue or better productivity. In the military environment, this payoff is either characterized as increased “readiness,” or the cost to increase “readiness” (a military expression that encompasses the availability and reliability of weapon systems critical for a warfighter). In Table 7 we consider the benefits resulting from adopting RFID technology in each particular application. We note that RFID technology has contributed with improvements in several competitive operations capabilities: quality (assurance or customer service), speed (process capacity or cycle-time), flexibility (service customization) and cost (labor reduction or theft control). In some cases



RFID technology has even enhanced some tactical capabilities such as asset location and process security—important concerns for both military and civilian operations.

Table 7. RFID Applications—Resultant Benefits

Case	Case Type	Benefits Resulting from the Use of RFID	Quality Assurance	Customer Service	Process Security	Process Capacity	Cycle-time	Item Location	Cost
<i>Toll tag</i>	CIV	Greater capacity, labor reduction, identification for peak load pricing and demand management		*		**	**		*
<i>Livestock tag</i>	CIV	Health control and product quality, inventory management	*		**			*	
<i>Railcar tag</i>	CIV	Reduced human error, accurate item location and order confirmation		*				**	*
<i>Soldier dog tag</i>	MIL	Custom medical care, reduced cycle-time and error rate, lower mortality	**				*		
<i>Standardized supply-chain tag</i>	MIL	Accurate shipment, increased speed and capacity, lower labor costs, location information				*	**	*	**
<i>Smart tire</i>	CIV	Better quality of information, lower operating cost	*		*				**
<i>Refrigerated trailer tag</i>	CIV	Better quality of information, ownership control, increased security	**		*				
<i>Night-vision goggles</i>	MIL	Access control, location information			**			*	
<i>Food ration (MRE) tag</i>	MIL	Improved quality based on improved monitoring and control	**			*			
<i>Vehicle tag</i>	CIV	Lower cycle-time, higher productivity, location information					*	*	**
<i>Smart and Secure Tradelanes (SST)</i>	CIV	Increased security, increased capacity, lower cycle-time			**	*	**		*
<i>Job shop tag</i>	MIL	Higher capacity, reduced cycle-time and labor costs, location information				**	*	*	*
<i>Total Asset Visibility (TAV)</i>	MIL	Accurate shipment, lower inventory obsolescence		*			*	*	**

Legend: CIV = civilian, MIL = military, ** = primary benefit, * = additional benefit

Within the RFID industry, there is considerable concern about identifying the benefits of RFID technology deployment (Wyld, 2005, p. 29). This is especially true as many suppliers struggle with mandates from major buyers (Wal-Mart, Target and others), mainly because it is very difficult for some to understand the benefits. Table 7 highlights the primary benefit realized in each application discussed in the previous section, as well as the additional benefits provided by the technology. Notice that the benefits provided by a given

system design depends on the process where it is deployed. If the objective is to simply manage product flow, passive tags using the standard EPC frequency are the logical choice. However, minimalist designs may generate little results (in fact, if product flow is the only objective, why not use the barcode?). So, the manager must keep in mind that, in order to justify the adoption of RFID technology, there must exist other benefits associated with the investment—preferably benefits that enhance the competitive capabilities of the organization.

RFID is not the first automation technology that has caused frustration among early adopters. In the 1980s, manufacturers encountered the same difficulty in estimating costs and benefits of computer-integrated manufacturing (Kaplan, 1986). However, open-network RFID adds another level of difficulty inasmuch as it requires that many players—not just one company—understand and benefit from the value provided by the technology, even if that value is not easily measured. Every firm in the network must understand the utility created by the technology and be able to capture some of this utility in the form of revenue increase and/or cost savings. Otherwise, the network suffers from unsustainable externality that leads to some players not making the appropriate investment. For instance, in retail applications, there are two major benefits from using RFID: better inventory management with the reduction of the bullwhip effect (Fleisch & Tellkamp, 2005) and better on-shelf availability (Langford, 2005). However, both benefits lean strongly in favor of the retailer, while the manufacturer bears most of the variable cost. Supply-chain partners with significant information sharing experience, such as Wal-Mart and Procter & Gamble, benefit from improving the quality of real-time information that they can share since the benefit of using the information outweighs the costs of implementing and maintaining the technology. But the same benefits have not been clearly observed by many small retailers and manufacturing companies or other organizations that do not share supply-chain information with buyers or suppliers.

Some prominent RFID applications are geared towards increasing a facility's capacity. However, the value of increased throughput is non-trivial to calculate. For example, how should we measure the value of increasing throughput at a port of entry operating at full capacity (such as the Port of Los Angeles and Long Beach) with a land constraint that prohibits expansion? Similarly, how should we measure the value of increased capacity at a tollbooth with similar land constraints—as in the many urban tunnels and bridges in New York City, Boston or San Francisco? In these cases, increased throughput is needed, but the actual value of this increased throughput cannot be easily measured since measurement requires comparison to the situation where the technology is not implemented; *that* is very hard to do.

Likewise, the benefit for the Department of Defense, an early adopter of RFID technology, is hard to quantify. Although the cost savings associated with better inventory management can be calculated with the appropriate financial metric, the value of “readiness” (an important performance measure in the military community) is much harder to trace back to any particular technology investment (Estevez, 2004). This challenge is similar to measuring the benefit gained with other subjective improvements, such as better quality management or better customer service, where the correlation between these management practices and financial performance measures is unclear (Kaplan, 1986). Quantification is even more difficult within the framework of traditional cost-benefit analyses of the rudimentary kind conducted in most organizations (Doerr & Gates, 2004).



The Costs of RFID operation

An RFID network incurs costs that are related to its implementation and costs that are related to its operation. The implementation costs and the costs related to learning how to use the technology are quite significant because it is a technology that usually requires significant time to master. Moreover, there is no evidence that the learning cost varies with the size of the system. Since high fixed costs indicate economies of scale, there is little incentive for small companies to adopt RFID outside the structure of a large network. The initial learning cost creates incentives for large organizations to become early adopters because they can amortize fixed costs more easily than small organizations can, which perhaps explains the early leadership of Wal-Mart and the DoD.

The initial implementation requires the purchase and installation of hardware and software, as well as the managerial drive, to execute the project. The system operation requires manning and maintaining the system. Moreover, an open system requires continual replenishment of the tag population in the upstream stages of the supply chain.

During the growth phase of the operation, when the system is expanding and more objects are being tracked, the operation requires the continuous addition of new tags and the occasional addition of readers to prevent the creation of bottlenecks. Open system applications encourage, and often require, the continuous introduction of new disposable tags. However, if the tags are reusable, the operation should include the collection of used tags (but the replenishment with new tags is not completely avoided since some of them are inevitably lost or damaged in the process).

Open systems tend to create an asymmetry between the beneficiaries of RFID investment and those who bear the variable costs of maintaining the system. Although all parties must invest in the infrastructure (readers, hardware and software), only the manufacturers bear the cost of tagging their products, while distributors and retailers (concerned with managing a very large number of stock-keeping units) have the benefit of inventory control with relatively little direct cost. This problem was also observed earlier with the introduction of electronic data interchange (EDI) and was discussed by Riggins et al. (1994). It is also the likely reason behind the small companies' reluctance to adhere to the retailers' request to tag all products.

The cost and benefit of closed RFID networks are usually born and enjoyed by a single organization. The initial implementation process is not too different from the implementation of an open network. However, it is easier to design a system relying on reusable tags, since the network belongs to a single entity: a company or a consortium of companies with clear policies regarding the operation of their RFID network. Because of the clear boundary around the system and the relative stability of the network structure, closed networks usually have a fixed number of reusable tags that can be amortized over a long period of time. New tags are introduced in the system only during the growth phase and to replace damaged tags. Consequently, investment on closed RFID networks using active tags may show a payback period as short as 12-18 months (Armanino, 2005).

Real Options Approach to RFID Investments

Net Present Value (NPV), Return on Investment (ROI), and Payback Period are tools commonly used to evaluate routine investments in technology when the costs and benefits of technology implementation are clear-cut and can be easily quantified. For example, investment in a machine that replaces a certain amount of labor effort can be evaluated by



estimating the NPV of the initial investment outlay and the reduced labor costs over the economic life of the machine. However, these tools are mostly inadequate when it comes to evaluating investment in an infrastructure technology that is strategic and long-term in nature. The main reason for such inadequacy is that such technology is usually characterized by the myriad ways it can be deployed, with a high level of uncertainty associated with its benefits. Projected cash flows based on the initial use of the technology seem small in comparison to the investment required. Or, the discount rate chosen to compensate for the risk becomes so high that it makes the NPV look tiny or negative. Considering the level of uncertainty coupled with the embedded options available in RFID's adoption, we believe that Real Options Analysis is a more suitable approach for valuing such technologies.

An option represents freedom of choice after the revelation of information, and it is a right but not an obligation. Options on financial instruments have been used in financial markets for a number of years, but the idea of real options (i.e., options pertaining to the future use of real things) has emerged only in last decade (Amran & Kulatilaka, 1998; Copeland & Antikarov, 2003; Adner & Levinthal, 2004; Munn, 2002). The main idea underlying this approach is that when evaluating the projected return on RFID investments, the manager also considers the value of future RFID-related opportunities (options) that these current investments might generate. In using the real-options analysis, one can view RFID technology as a bundle of capabilities that may have immediate paybacks but may also be "stepping stones" to future capabilities. It may, therefore, make sense for the manager to consider the possible future value of some of these stepping-stone investments that pre-position the organization for future opportunities that can be grasped when key uncertainties are adequately resolved (i.e., technology capabilities, customer acceptance, etc). At that moment, the option to use (or not use) RFID technology may be exercised or allowed to lapse. The real-options methodology provides tools and techniques for capturing this value-creating aspect of RFID investments. RFID Technology offers a number of valuable, real options (Patil, 2004):

- **Growth:** A small initial investment in RFID as a data-collection platform can serve as an infrastructure for other valuable projects in the future. For example, use of RFID for pallet-level tracking may be extended to item-level tracking in the future.
- **Flexibility:** A resource may be acquired initially with a specific purpose in mind, but (depending on the flexibility of the resource) it may be used in the future to also serve some other need. For example, a hand-held reader used at the check-out counter may be used within cycle counting to better manage purchasing and inventory-control functions.
- **Innovation and learning:** New technologies are invariably associated with steep learning curves, and hence, hands-on learning is one of the best ways to better understand the new technology and its potential applications. For example, the use of RFID allows an organization to collect information about products moving through the supply chain. This ability can be subsequently leveraged to create product tracking information to improve customer service and delivery reliability.
- **Waiting:** At times, the value of waiting to adopt a technology until better market information becomes available may exceed the value of its immediate adoption. For example, in applications where the existence of standards is important, there is value in waiting to see which technology becomes the industry standard.

- **Abandonment:** The ability to abandon and walk away from a technology if it becomes a failure is a valuable option to retain in early technology adoption decisions.

It should be noted that RFID not only generates value directly in the short-term but also enables introduction and implementation of various value-generating applications in the long run. Hence, we recommend that in evaluating and justifying an investment in RFID, a manager follow an approach that is a hybrid of the traditional tools of NPV or ROI and the real-options theory. For example, investment in RFID can be viewed first as an acquisition of a data-collection platform that reduces the costs of data collection by making the current data-collection process more efficient. The NPV of this base level of benefits is first assessed. Next, the manager should identify the options applicable in the given situation and estimate their associated NPVs based on when these options could be exercised and the value of the applications they represent. The combined NPV of the base level of benefits and the options discussed above should provide sufficient basis for a manager to meaningfully evaluate and justify the investment in RFID.

Conclusions

RFID is a promising technology, and many organizations are presently contemplating its adoption to improve the operational performance of a variety of processes. As in the case of any new technology adoption, managers must consider two major issues before adopting the RFID technology: selection of the right configuration and justification of the technology investment. Helping managers deal with these issues is the main objective of the current research.

Since the use of RFID technology in business application is quite recent, we used the methodology of case research. Specifically, we studied 13 cases of RFID applications, in both civilian and military settings, so as to develop a better understanding of how RFID technology configurations are selected in practice. In each case, we identified the operational needs and the choice of technology configuration made by the firm or organization. This data was further analyzed in a qualitative manner to determine if there exists any relationship between these two and how operational needs influenced the choice of technology configuration. The results of this analysis were used to propose conceptual frameworks in the form of sets of rules that a manager can use to select the appropriate RFID technology configuration.

Since justification is an important issue in adopting any new technology, a manager must identify an approach that is most suitable for the justification of his/her particular choice of RFID technology. To provide a managerial guideline in dealing with this issue, we evaluated appropriateness of traditional methods such as net-present value analysis and return on investment, as well as the more recent real-options analysis. We found that, given the level of uncertainty associated the resulting benefits of RFID and the existence of multiple options available in its deployment, the real-options approach (as opposed to traditional methods) is more appropriate for valuing RFID technology.

RFID technology is in its early phases of adoption, and we are just scratching the surface of the benefits that this technology can provide. The principle advantage of RFID technology is that it can not only inform a reader and system what and where an item is but also what condition the item is in. As a sophisticated data-gathering platform, RFID technology can be used to support and enhance the decision and control capabilities in



computer-integrated manufacturing and service operations; in many ways, therein lays the greatest potential for RFID.

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Investigating the Department of Defense's Implementation of Passive Radio Frequency Identification (RFID)

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Emeterio V. Hernandez, Captain, United States Air Force, received his Master of Business Administration with a concentration in Acquisition and Contract Management from the Naval Postgraduate School in December 2005. Prior to this assignment, Captain Hernandez, a Logistics Readiness Officer, served as a Fuels Staff Officer for the Air Force Petroleum Office, Detachment 3, Warner-Robins Air Logistics Center, Fort Belvoir, Virginia. He also served as the Flight Commander, Combat Operations, with the 49th Supply Squadron, 49th Fighter Wing, Holloman Air Force Base, New Mexico and had an outstanding enlisted career of 13 years as a Fuels Specialist. Captain Hernandez is a 1998 graduate of Eastern Washington University, where he received a Bachelor of Science in Biology. Captain Hernandez' next assignment is as a Research Analyst with the Air Force Logistics Management Agency, Maxwell Air Force Base-Gunter Annex, Alabama.

Executive Summary

PURPOSE

The purpose of this report is to study the implementation process of passive RFID throughout the Department of Defense and determine whether or not the process explicitly or implicitly followed typical executive modeling formulas. It will also determine the problematic areas in the implementation of such an emerging technology and the best way to overcome those problems throughout an organization of the magnitude and complexity of the Department of Defense.

INTRODUCTION

1. Background

During Operation Desert Storm, there were 42,000 containers that went to AOR. The Army had to open 28,000 to find out what was inside. The Army found a solution to this problem in Active RFID. US European Command and US Central Command went to the Joint Staff who went to the OSD with this solution. The OSD directed the DoD AIT to write the policy for active RFID and included passive RFID within the mandate. The OSD required external suppliers to use passive RFID tags and also required the Services to pursue passive RFID with Integrated Product Teams. The final policy stated that passive RFID would be implemented in a phased implementation to be completed in 2005, 2006, and 2007. Additionally, the OSD AT&L required all services and agencies to upgrade their



logistics systems from the military logistics systems (MILS) to the defense logistics management system (DLMS) within the year. It is apparent that the initial COCOM requirement was altered to include the implementation of an item that the OSD felt was an important part of the transformation of the Department of Defense.

2. Project Objectives

This research project specifically focuses on the discovery of the methods used and the models followed to implement an emerging technology within the Department of Defense. It also concentrates on the discovery of barriers to the implementation of an emergent technology and possible solutions to those barriers.

METHODOLOGY

- Conduct interviews with key Department of Defense personnel involved in the planning and implementation of passive RFID technology.
- Ask unbiased key questions in an uninhibited environment to allow interviewees the ability to answer questions in a non-bureaucratic manner, thereby collecting data that can be analyzed for dissemination and discovery.
- Analyze the responses to each question by each interviewee to discover common themes to be used in the categorization of responses and utilize those themes to discover common barriers to the implementation of passive RFID throughout an organization like the DoD.

FINDINGS AND ANALYSIS

There is a lack of synchronization of three key elements that has created a barrier to the implementation of passive RFID at the pace prescribed by the OSD. Those three key elements are automated information and communication systems integration, passive RFID technology maturity, and DoD/Service business processes. This study disagrees with the GAO report which states that passive RFID needs better management to work. This study concludes that passive RFID is following the prescribed course of implementation of an emerging technology by following the processes of:

- Forward-looking policy creation by the OSD.
- A lack of synchronicity between automated information and communication systems integration/passive RFID technological maturity.
- Resistance and concern by the Services as to the necessity and cost of implementing an immature and emerging technology into obsolete legacy systems.
- Our analysis reveals that:
- Passive RFID implementation is progressing in a manner conducive to the implementation of an emerging technology combated by so many factors.



- The GAO's recommendation that "passive RFID needs better management to work" offers little assistance to the implementation of passive RFID.
- The DoD should slow the implementation process to allow for the synchronization of the three elements that would result in the immediate exploitation of the technology. Those elements are:
 - Automated information and communications systems integration
 - Passive RFID technological maturity
 - DoD/Service business processes

RECOMMENDATIONS

- Key stakeholders must reevaluate passive RFID policy and implementation in order to coordinate the three key elements in a 2010 timeframe. Until that point, BCAs will be redundant with insignificant results; implementations will be costly and risky, and post-implementation analysis will show poor returns resulting from costly legacy-system integration and premature business process reengineering.
- Key stakeholders must continue pursuing the exploitation of active RFID to fulfill COCOM requirements through the ingenuity of the warfighters who have championed the implementation process.
- Key stakeholders must maintain the passive RFID implementations at Susquehanna and San Joaquin as anchors for the maturity of the technology within the DoD. They must also utilize these sites for piloting activity and metric collection as well as starting points from which the Services should begin implementation.

BOTTOM LINE

It does not make good business sense for the DoD to continue with its current approach of implementing passive RFID. The DoD will continue to have significant difficulties and will never successfully overcome the barriers observed in this analysis until the coordination criteria is met. However, if the DoD gives proper attention to our recommendation and delays implementation until the three key elements appropriately synchronize, the DoD will have found the coordination match needed to successfully implement an emerging technology and to provide a model for future implementations.



Panel – Transforming the DoD Acquisition Enterprise

Wednesday, May 17, 2006	Transforming the DoD Acquisition Enterprise
1:30 p.m. – 3:00 p.m.	<p>Chair:</p> <p>Steve Kelman – former Administrator of the Office of Federal Procurement Policy, U.S. Office of Management and Budget; presently Professor of Public Management, John F. Kennedy School of Government</p> <p>Papers:</p> <p><i>Changing Major Acquisition Organizations to Adopt the Best Loci of Knowledge, Responsibilities and Decision Rights</i></p> <p>Mark Nissen, Naval Postgraduate School</p> <p>Frank Barrett, Naval Postgraduate School</p> <p><i>Transforming the Enterprise of Acquiring Public Sector Complex Systems</i></p> <p>William Rouse, Georgia Institute of Technology</p> <p>Michael Pennock, Georgia Institute of Technology</p>

Chair: Steven Kelman is Albert J. Weatherhead III and Richard W. Weatherhead Professor of Public Management, John F. Kennedy School of Government, Harvard University. From 1993-1997, he was the Administrator of the Office of Federal Procurement Policy at the U.S. Office of Management and Budget, where he was a leading figure in reinventing government efforts. He is a Fellow of the National Academy of Public Administration and serves on the Editorial Board of the Journal of Public Administration Research and Theory. He is the author of *Procurement and Public Management: The Fear of Discretion and the Quality of Government Performance* and of *Making Public Policy: A Hopeful View of American Government*. His earlier books include *Regulating America*, *Regulating Sweden: A Comparative Study of Occupational Safety and Health Policies; What Price Incentives?: Economists and the Environment*; and *Push Comes to Shove: The Escalation of Student Protest*. Kelman's research on public-sector operations management focuses on organizational design and change.



Changing Major Acquisition Organizations to Adopt the Best Loci of Knowledge, Responsibilities and Decision Rights

Presenter: Mark Nissen, PhD, is Associate Professor of Information Systems and Management at the Naval Postgraduate School. His research focuses on knowledge dynamics. He views work, technology and organizations as an integrated design problem and has concentrated recently on the phenomenology of knowledge flows. Mark's publications span information systems, project management, organization studies, knowledge management and related fields. In 2000, he received the Menneken Faculty Award for Excellence in Scientific Research, the top research award available to faculty at the Naval Postgraduate School. In 2001, he received a prestigious Young Investigator Grant Award from the Office of Naval Research for work on knowledge-flow theory. In 2002, he spent his sabbatical year at Stanford integrating knowledge-flow theory into agent-based tools for computational modeling. Before his information systems doctoral work at the University of Southern California, he acquired over a dozen years' management experience in the aerospace and electronics industries.

Frank Barrett, PhD, is Associate Professor of Systems Management at the Naval Postgraduate School in Monterey, California, where is also Director of the Center for Positive Change. He received his BA in Government and International Relations from the University of Notre Dame, his MA in English from the University of Notre Dame, and his PhD in Organizational Behavior from Case Western Reserve University. He has also served on the faculty of The Katholieke University of Leuven in Belgium, Penn State University Behrend College, Case Western Reserve University, and Illinois Benedictine College. He has taught courses in Management, Organizational Behavior, Organizational Theory, Group Dynamics and Leadership, Organizational Design, Organizational Development, and Organizational Change.

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Abstract

The DoD is a large, bureaucratic, rule-intensive organization that may no longer be best suited for its new environment. Building upon prior, multidisciplinary research, we draw



upon the best knowledge and practice in change management, and analyze transformation from the classic Hierarchy to the Edge-like Holonistic organization, which offers excellent potential for performance improvement. Such analysis focuses on the processes of change from one organizational form to another and leads to the generation of transformational plans, which can be used by acquisition leaders, practitioners and policy makers to outline steps—and leaps—required to affect fundamental organizational change. We also build upon prior work on computational modeling and experimentation to develop models of the transformation process, and we explore such models to emulate the behavior of the alternate transformational plans noted above. By modeling and experimenting with processes of change, as opposed to processes of ongoing organizational routines, we begin to extend the state-of-the-art in computational modeling and experimentation. Practically, answers to our research questions have direct and immediate application to acquisition leaders and policy makers. Theoretically, we generalize to broad classes of organizational transformations and prescribe a novel set of organizational redesign guides.

Keywords: Acquisition, change management, computational modeling, organizational design, project management, qualitative methods.

Introduction

Acquisition is big business. Drawing from Dillard and Nissen (2005) in this section, we note that the US Department of Defense (DoD) alone executes routinely eleven-figure budgets for research, development, procurement and support of weapon systems, for instance. Acquisition is also a rule-intensive business. In addition to myriad laws governing federal acquisition in the US, a plethora of regulations specify—in great detail often—how to accomplish the planning, review, execution and oversight of Government acquisition programs, large and small, sole-source and competitive, military and commercial (Dillard, 2003). Due in great part to the large size and many rules associated with Defense acquisition in particular, the organizations responsible for DoD acquisition activities tend to be large and rule-intensive themselves, reflecting the kinds of centralized, formalized, specialized and oversight-intensive forms corresponding to the classic Machine Bureaucracy from Organization Theory (e.g., see Mintzberg, 1979). Bureaucratic organizations are known well to excel in terms of efficiency when situated in stable, predictable environmental contexts, but this classic organizational structure is also known well to be exceptionally poor at anticipating and responding to change. In the context of military transformation, the associated problem should be clear and compelling: the Defense acquisition environment today is neither stable nor predictable.

Prior Research to Investigate this Problem

Prior research to investigate this problem (Dillard & Nissen, 2005) examined the *Hierarchy* with respect to two alternate organizational forms: *Decentralized* and *Holonistic*, which were identified theoretically to offer potential to improve the performance of Defense acquisition organizations. This empirical examination was conducted in two contrasting environments contexts: *Routine* and *Stressful*, which characterize the acquisition environments of yesterday and today, respectively. Using computational models of the Hierarchy and two alternate organizational forms, across the two contrasting environmental contexts, a 3x2 factorial experiment was conducted to assess the relative performance of each organizational form and environmental context combination.



Table 8. Prior Experimental Results (adapted from Dillard & Nissen, 2005)

Measure	Typical Organization in Routine	Decentralized Organization in Routine	Holonistic Organization in Routine	Typical Organization Under Stress	Decentralized Organization Under Stress	Holonistic Organization Under Stress
Duration (dys)	556	428	407	580	604	458
Cost \$K	\$8,085	\$4,674	\$4,565	\$8,561	\$6,708	\$4,973
Project Risk	0.41	0.54	0.76	0.37	0.55	0.76
Max Backlog (dys)	26	12	12	30	27	19
Work Volume (dys)	4800	4500	4500	4800	4500	4500
Rework Volume (dys)	124	866	465	401	2747	740
Coordination Volume (dys)	3051	423	742	3205	952	976
Decision Wait	20	54	0	67	186	0

Table 1 summarizes the prior experimental results for reference. The table includes measures for project duration, cost, risk, and other key dependent variables that provide insight into comparative organizational performance. The six columns represent each cell of the 3x2 factorial experiment. The first three cells summarize performance of the Hierarchy (labeled “Typical Organization”), Decentralized and Holonistic organizational forms in a Routine environmental context. Notice that both of the alternate organizational forms reflects shorter project schedules (i.e., measured by *duration*; 428 and 407 days for the Decentralized and Holonistic, respectively, vs. 556 for the Hierarchy) and lower project costs (i.e., measured in \$K; \$4674 and \$4565 for the Decentralized and Holonistic, respectively, vs. \$8085 for the Hierarchy) than the Hierarchy does. Alternatively, both alternate organizational forms reflect higher project risk (i.e., measured in terms of project exceptions that were either not reworked or not reworked completely (lower is better); 0.54 and 0.76 for the Decentralized and Holonistic, respectively, vs. 0.41 for the Hierarchy) than the Hierarchy does. Hence, one can observe a seemingly fundamental tension between project speed and cost versus risk (see Nissen & Buettner, 2004), a tension that requires either explicit or implicit tradeoffs to be made by leaders and policy makers interested in the performance of acquisition organizations.

The next three cells summarize performance of these same three organizational forms in a Stressful environmental context. Notice first that, in terms of project duration and cost, all three organizational forms perform worse under environmental stress than they do in a routine environment, but that project risk does not change appreciably between the two contrasting environmental contexts. Hence, all three organizational forms appear to be quite sensitive to stress in terms of schedule and cost, but appear also to be relatively robust to stress in terms of risk. One can see how this prior research is elucidating the relative, contingent characteristics of alternate acquisition organizational forms and environmental contexts.

Notice second that, as above in the routine environmental context, both of the alternate organizational forms reflects lower project costs (\$6708 and \$4973 vs. \$8561) and higher project risk (0.55 and 0.76 vs. 0.37) than the Hierarchy does. However, in contrast with the former results, schedule performance by the Decentralized organization is worse than that of the Hierarchy (604 vs. 580 days); yet, the Holonistic organization maintains relatively good schedule performance (458 days). Not only does the Holonistic organization outperform its Hierarchy and Decentralized counterparts in terms of project duration and

cost, this form appears to be the most robust to environmental stress, as the effect of such stress on its relative performance is much smaller than on the relative performance of the other two organizational forms.

To summarize, the seemingly fundamental tension between project speed and cost-versus-risk persists across contrasting environmental contexts, and necessitates either explicit or implicit tradeoffs to be made by leaders and policy makers interested in the performance of acquisition organizations. Plus, the three organizational forms react differently to environmental stress, which necessitates another set of tradeoffs to be made—explicitly or implicitly. As such, acquisition leaders and policy makers have new knowledge about contingent relationships between alternate organizational forms and their relative performance across contrasting environmental contexts. Such knowledge enables a new—or at least previously unrecognized or ignored—capability to *design*, or more appropriately to *redesign*, organizations to perform better in the changing acquisition environment of today and tomorrow.

Moreover, because such leaders and policy makers retain considerable control over organizational designs, the associated transformation from one organizational form (esp. the Hierarchy) to another (e.g., Decentralized or Holonistic) can be affected largely without reliance upon new regulations or legislation. In combination with acquisition reforms that have been ongoing for a decade or more, this provides seemingly unprecedented power to acquisition leaders and policy makers to improve the performance of the organizations in their charge. Notwithstanding such new knowledge, capability and power, however, *knowing what* organizational design is most likely to perform best in a given environmental context does not imply that *knowing how* to accomplish the required redesign will follow. Indeed, the question, how to change major acquisition organizations to adopt the best loci of knowledge, responsibilities and decision rights, is more difficult than—yet follows directly from—the question above concerning which organizational form to select. This latter “knowing how” question is addressed through research described in the present article.

Present Research to Address Organizational Redesign

Building upon the prior research summarized above, we draw upon the best knowledge and practice in change management (e.g., including models of planned change, change typologies, large-scale change, and sense-making) to analyze transformation from the classic Hierarchy to the two organizational forms (*Decentralized* and *Holonistic*) in the acquisition domain. As suggested above, such analysis focuses on the *processes of change* from one organizational form to another and leads to the generation of transformational plans—involving both radical and incremental means—which can be used by acquisition leaders, practitioners and policy makers to outline steps—and leaps—required to affect fundamental organizational change.

We also build upon prior work on computational modeling and experimentation to develop a preliminary model of the transformation process. With further model development, exploration and refinement, we hope to utilize such a model to emulate the behavior of the alternate transformational plans noted above. By modeling and experimenting with processes of change, as opposed to processes of ongoing organizational routines, we can extend the state-of-the-art in computational modeling and experimentation. Practically, answers to our research questions have direct and immediate application to acquisition leaders and policy makers. Theoretically, we generalize to broad classes of organizational transformations and prescribe a novel set of organizational redesign guides.



With this research agenda expressed, the balance of the article begins with description of the three-part research design. We then articulate the qualitative research findings, and follow with relatively in-depth discussion of planned change. A preliminary, computational model of one change process follows in turn. The article closes with key conclusions, implications for practice, and topics for future research to continue building upon this investigation.

Research design

This discussion of the research design is organized into three parts: 1) qualitative inquiry, 2) theoretical analysis, and 3) computational experimentation. This integration of three, distinct research methods enables a degree of empirical grounding, theoretical synthesis, experimental control and triangulation that would be difficult, if not impossible, to achieve otherwise. Each part is discussed in turn.

Qualitative Inquiry

We undertake a qualitative research study to investigate the deep meaning associated with managing acquisition organizations, and to draw directly upon the experiences of veteran acquisition managers. The major portion of this study is conducted by a team of PhD students working under supervision of the authors. We acknowledge their helpful contribution here. The emphasis of this qualitative fieldwork is upon project managers, who offer insight into conditions that signal organizational change, and into reactions to such conditions. Grounded theory building along the lines of Glaser and Strauss (1967) provides the key methodological guide for the study, with heavy utilization of interviews guided in large part by Rubin and Rubin (1995). The two, interrelated research questions addressed through this fieldwork are: 1) how does the acquisition manager know when change is needed? and 2) what are the enablers and obstacles to create successful organizational change? Clearly such fieldwork supports the overall focus of the research described in this article, and such qualitative analysis complements well the other methods employed.

This summary of the qualitative research method draws heavily from and synthesizes the ideas of Bourazanis (2005), Bush (2005), Gateau (2005) and Mirano (2005). The students interviewed four experts in the field of acquisition. All four had acquired significant program management and acquisition experience, as well as operational military experience. All were retired, senior, US military officers, including two Army Colonels, an Air Force Lieutenant Colonel and a Navy Commander. This provides a basis for comparison across three US Military services, yet focuses on experienced, senior professionals. Their status as retired military officers introduces a somewhat rarefied perspective into the study, as their first-hand acquisition experiences took place several years in the past. However, each informant indicated vivid recall of the past events, and confirmed ongoing understanding of events and changes in the acquisition field since retirement. Indeed, all four informants serve currently as acquisition faculty members whose primary professional purpose involves staying current in the acquisition field.

The four interviewers worked collaboratively to develop a common, semi-structured protocol with ample opportunities for probing, snowballing and follow-up. Each interview lasted roughly sixty minutes and was recorded and transcribed. Each of the four students transcribed, coded and analyzed one of the four interviews independently, but the four interview transcripts were pooled for use by all four students. Hence, each student had



access to, and conducted his analysis across, all four interview transcripts; yet, each student produced his own, independent paper from these qualitative data. The authors of this present article also read through the four interview transcripts, as well as the student papers, and developed their own, synthesized interpretation by treating the student syntheses as secondary data.

Theoretical Analysis

Theoretical analysis represents the centerpiece of this article as we draw from the change literature—broadly defined—to address the “how to change” question posed above. This theoretical analysis is framed to complement the qualitative results, and focused to help guide computational model development. As such, it represents a metaphorical fulcrum, which leverages qualitative research on one side against computational experimentation on the other. Mixing metaphors, we *sandwich* theoretical analysis between two empirical studies: qualitative results that have been analyzed and computational experimentation yet to be accomplished.

Computational Experimentation

We undertake a study based upon computational experimentation, which builds directly upon prior work along such lines by Nissen and Levitt (2004) and Dillard and Nissen (2005). As highlighted first by Nissen and Buettner (2004), computational experimentation bridges the chasm between analytical and laboratory methods on the one side—which are powerful in terms of control, but suffer from problems with external validity and generalizability—and field methods on the other side—which are powerful in terms of realism, but suffer from problems with internal validity and reliability. Particularly when integrated with other research methods, computational experimentation provides a powerful approach to addressing difficult questions pertaining to organizations.

Our key departure in this present research pertains to the object of our modeling and experimentation. Whereas previous computational modeling and experimentation have focused on the structures and behaviors of organizations and their operational processes, the focus here is on the processes of change. Clearly organizations and their processes are involved in change models too, but the nature of such organizations during change is likely to differ in key respects from those not undergoing change, and the processes associated with change will clearly differ from those involved with routine operations. As an illustrative example, a classical manufacturing firm (e.g., US automobile company) would be modeled to represent the structure and behavior of its bureaucratic organization and assembly processes. But this same firm, when undergoing change, might be modeled instead to represent the structure and behavior of a cross-functional, ad-hoc change team and processes of organizational redesign and resistance mitigation.

The computational modeling and experimentation draw heavily upon the stream of work associated with the Virtual Design Team (VDT) Research Program (VDT, 2006), which has been described in considerable detail elsewhere (e.g., see Jin & Levitt, 1996; Kunz et al., 1998; Levitt, et al. 1999), and adapted specifically to the acquisition domain by Dillard and Nissen (2005). Adopting the VDT paradigm brings to bear nearly two decades of research which integrates well-accepted organization theory (e.g., Galbraith, 1977; March & Simon, 1958) with extensive empirical validation projects (e.g., Christiansen, 1993; Thomsen, 1998), and which has demonstrated excellent representational fidelity and both qualitative and quantitative validity in terms of operational organizations in practice. This



VDT paradigm also brings with it a well-refined and validated tool set for modeling the structures and emulating the behaviors of operational organizations.

In this study, we draw both from the qualitative fieldwork and, in particular, the theoretical analysis to identify candidate change organizations and processes to model. This effort remains highly exploratory, as computational modeling of change organizations and processes pushes the state-of-the-art. Indeed, it remains highly speculative even whether the VDT computational modeling suite of methods and tools can be used to represent and emulate the respective structures and behaviors of change organizations and processes.

Qualitative Findings

To re-iterate from above, the qualitative inquiry sought to answer two, interrelated research questions: 1) How does the acquisition manager know when change is needed? and 2) What are the enablers and obstacles to create successful organizational change? Addressing this first question first, the prevalent case suggests that the acquisition manager does not recognize the need for *organizational* change. Admittedly, the multiple interviews did reveal a common disdain for “the system” and its many constraints. For instance, we learn from one study that acquisition managers feel the “need to fix the program or at least make it look like [they’re] going to fix it.” The interviews reveal also that acquisition managers take an action-oriented approach. For instance, one study reports that acquisition managers will try new techniques: “He was the first program manager to embrace integrated product teams (IPTs) and integrated product and process development.”

But the nature of changes undertaken by acquisition managers in the study fell far short of the kinds of *organization* changes that are noted in the literature and emphasized in this study. Indeed, one study reports that “change for change’s sake” was common, and another states that “[w]hat the subjects, themselves, referred to as change, was very often not an actual change.” Indeed, we find reports of signaling change (e.g., through superficial re-organization) playing a larger role than change itself does (e.g., “reorganizations *look like* change”). Further, “[t]he majority of changes reported by the interviewees were in some way exogenous”; that is, change in its dominant form was imposed from above via hierarchical fiat. Hence, external authorities appear able to affect some kind of change upon acquisition organizations (e.g., via laws and regulations), but the organizations themselves appear unable to affect such change. This serves to reinforce our focus on the change process itself as a route toward change without reliance upon legal and regulatory authority, a route taken sparingly by previous researchers in this domain.

Addressing the second question reveals many of the enablers and obstacles to creating successful organizational change that are known well via both theoretical and empirical research on the topic. For instance, the hierarchical organizational form itself tends to resist change, and such resistance is noted in one of the studies as “constraints on innovation imposed by the military hierarchy.” As another instance, the bureaucratic nature of the acquisition organization hierarchy limits the power of acquisition managers: “one of the greatest challenges that a program manager is facing is the civilian personnel and civil service—the ability to fire people, the ability to hire the right people.”

We also find risk aversion as another induced attribute of change resistance that is noted often in the literature: “one bad choice is likely to result in significant repercussions, both personally for the change agent and for the program. [...] This drives decision makers to look for the lowest-risk option [...] [which] quite often means not changing at all.” Internal



organizational problems surface through our studies as well. For instance, “the lack of coordination among the IPT leaders led to [a] waste of time and undermined the reputation of the acquisition organization as well.” This suggests also a contingency problem of *fit* (see Burton & Obel, 2004) between the hierarchical form of acquisition organizations and their ability to change; and it begins to elucidate the insidious and constraining nature of the hierarchy: not only does it represent an organizational form that is unsuited in several respects for its current, dynamic environment, but this form resists change to other forms. Introducing some anthropomorphication here, one could say that the hierarchy is *stubborn*.

Additionally, we find an apparent absence of foresight among acquisition managers that corresponds well to the change literature we explore below. More specifically, this is consistent with the assumptions from the Carnegie model of decision making and, as we show, suggests that beginning with engineering-focused interventions may be self-limiting. For instance, we discover from one study that most acquisition managers “seemed not to be looking for an ideal solution, instead either choosing a solution from the ‘toolbox’ or adopting a non-ideal [...] solution.” More than one study suggests that acquisition managers—project managers in particular—may possess a unique set of capabilities and dispositions, as terms such as *overly optimistic* appear throughout. Indeed, we find considerable evidence that acquisition managers possess and defend a very strong sense of *identity*: a set of norms, beliefs and reflexive perceptions that guide both understanding and behavior. Even as organizational change is mandated from above, this strong identity prevents substantive change from within, and the organizational form itself exacerbates the situation, as acquisition managers are relegated to “doing what they can,” and to applying “known good solutions (in other situations) to the existing problem.” This presents us with something of a paradox: *the acquisition organization manifests a need to change form, but its very form inhibits such change*.

Alternatively, the studies reveal some potential avenues for change also. For instance, within the *toolbox* notion from above, we find that acquisition organizations do change—at least superficially—with some regularity, “moving between established organizational repertoires.” We also learn about “administrative effort, refocus and ‘change for change’s sake’ that ensued with each leadership turnover.” Apparently, the tenure of a typical acquisition manager is relatively short, and, hence, acquisition managers tend to change positions relatively frequently. With each such leadership change comes an opportunity for organizational change. Further, changes with exogenous impetus appear to be accepted with relative ease by the acquisition organization: such “changes are generally adopted and acted upon with little significant resistance.” Thus, the qualitative results suggest that established organizational repertoires may provide feasible avenues for change. Perhaps the acquisition organization can *be taught* novel routines to add to such repertoires. Also, each seemingly frequent leadership change could be combined with broader, more systematic efforts to redesign the acquisition organization from within. As above, however, the current set of acquisition managers may not have requisite knowledge to affect such internal redesign, and their strong sense of identity may preclude them from committing to the kind of transformational, internal change required. The challenge then is formidable. Clearly, if DoD acquisition organizations are going to change to the degree and depth that managers envision is needed, it will constitute nothing less than a change in the collective identity of the organization(s). Identity change is a topic we return to below when we consider change models and interventions.

Clearly, we must reach beyond the qualitative data and inductions discussed here and draw from theory to understand *how* such three points could be integrated. Further, we



must reach in turn beyond such theory, and pursue a program of empirical comparison to assess the relative advantages and disadvantages of this and other approaches to changing the acquisition organization fundamentally. The next two sections summarize such theoretical and empirical reaching.

Planned Change

The qualitative findings above suggest that perhaps the field of organizational change can shed some light on the challenge facing Acquisition Organizations. This focused review of the change literature relevant to our study is organized into five parts: 1) Models of Planned Change, 2) Change Typologies and Planning the Flow of intervention types, 3) Intervention Models within DoD, 4) Sense-making as a tool to understand change processes, and 5) the Logic for beginning with socializing interventions and Large-scale Change.

Models of Planned Change

As many have noted, planned change is usually initiated because of the need for an organization to adapt. Representations and typologies depicting change approaches vary. Some emphasize the level of planned change as first or second order (Bartunek & Moch, 1987); some emphasize degree of change (incremental or radical); others emphasize the target of planned change; others the pace of change or the tempo of change (episodic or continuous). First, we investigate the kind of change involved in moving an acquisition organization from bureaucratic to holonistic, or what we are calling “power to the edge” (see Alberts & Hayes, 2003), using Dunphy’s (1997) typology. This helps us appreciate the radical nature of change. It also provides a logic for why it is necessary to focus on the theory underlying the intervention (in this case, the nature of sense-making as a way to understand human behavior during radical change), and finally, the logic for why socializing interventions and large group interventions are appropriate because they tend to account for the nature of sense-making in cases such as the one we are exploring.

Dunphy suggests that any theory of change must account for five components: 1) basic metaphor of the organization; 2) analytic framework; 3) ideal model; 4) intervention theory; and 5) role of change agent. We explore these components and consider how they apply to the case of changing from bureaucracy to holonistic, or “edge-like” organizations. Dunphy suggests that any change intervention must account for: 1) a basic metaphor of the nature of organization; 2) an analytic framework or diagnostic model to understand the change process; 3) an ideal model of an effective organization that includes targeted outcomes; 4) an intervention theory that specifies where, when and how to intervene; 5) a definition of the role of the change agents.

Change in the basic metaphor of the organization: from centralized power to “edge” power. The bureaucratic metaphor sees organization as predictable, relying on patterned routines; change is infrequent and driven from the top; interdependence is usually sequential and coordination occurs through plans. The holonistic metaphor envisions an organization that is emergent, self-organizing; people are empowered to make decisions based on knowledge and expertise rather than by authority position; change is constant, evolving, and cumulative. Interdependence is often reciprocal, and coordination occurs through negotiation.



Change in analytic framework. Bureaucracies seek equilibrium, so change is seen as an occasional interruption or divergence. Changes are often driven externally and often seen as a failure to adapt. Adaptations tend to be short run and scope tends to be macro or global. In holonistic organizations, change is seen as an endless modification in work processes and social practice driven by alert reactions to daily contingencies; small accommodations cumulate and amplify. Change efforts emphasize long-run adaptability at the micro level. The key change is redistribution of decision rights and expertise to the edge of organization.

Ideal Model of effective organization: the ideal model of the mechanistic organization is one of efficiency and predictability, hierarchically ordered, in which planning and decisions occur at the strategic apex and are implemented at lower levels. The holonistic organization is one in which power is distributed to the edge; individuals are able to “sense and respond,” are empowered to initiate actions and changes when the situation arises. As a result, this organization is capable of continued adaptation.

Intervention theory: A bureaucratic acquisition organization is rule-driven and seeks to minimize disruptions. This tends to be consistent with a model of “punctuated equilibrium.” In a holonistic organization, change is continuous (Van de Ven & Poole, 1995). Executives are encouraged to notice instability, disorder, novelty, emergence, and self-organization for their innovative potential rather than as something to be avoided, eliminated, or controlled. This approach to change tends to be consistent with complexity theory in which the unexpected and unknown are resources for novel action, a responsive organization that operates at the “edge of chaos.” Rather than change perceived as something that must be anticipated, planned, and controlled, change is anticipated, unplanned and facilitated. Also, agents are richly connected (rather than functionally separated), and feedback is non-linear (rather than exclusively guided by chain-of-command norms). This last observation should be enough to signal that this is indeed a radical change that challenges habitual sense-making norms. (For this reason, below we explore in more detail traditional decision making theory that informs DoD bureaucracies and the need to understand the process of sense-making as a guide to choosing interventions that align with theories of sense-making).

Role of Change agent: Traditional acquisition organizations in which change is planned and occasional, change agents tend to be located in positions of hierarchical power. The change agent is seen as a prime mover who plans and directs, communicates action plans, builds coordination. In holonistic organizations (in which power is distributed), change agents are sense-makers who redirect the flow of change, focus on changes in the margins, facilitated improvisation, responsiveness, and learning.

By exploring each of these 5 components, we can see more clearly that the proposed change in DoD acquisition organizations is, in fact, radical along each of the dimensions. For our purposes, we explore in more detail below the change in intervention theory that is involved. Therefore, we begin by exploring a range of change typologies.

Change Typologies

One of the most enduring typologies of organizational change is the one proposed by Van de Ven and Poole (1995). They explore four basic process theories of change and posit different event sequences and generative mechanisms: 1) lifecycle theories, 2) teleological theories, 3) dialectical theories, and 4) evolutionary theories. By definition, planned change



approaches are teleological. Huy (2001) further elaborates the teleological model by outlining four different engines (or intervention theories) and, correspondingly, different kinds of change agents that are called for: 1) commanding approaches which are directed toward formal work structures; 2) engineering approaches directed towards work processes and job design; 3) teaching approaches that are directed toward beliefs; and 4) socializing approaches directed toward social relationships. These are ideal type models, and most large-scale change efforts involve combinations, if not inclusion, of all four intervention approaches. Therefore, we also seek to understand the importance of the order and combination of these approaches as we apply these types to DoD organizations.

Commanding Interventions: are aimed at changes in formal structures. Much of the strategic management literature assumes a commanding change model. Change agents tend to take on the role of commander engaging in activities like strategic planning, competitive analyses, and portfolio management. These efforts are traditionally directed by “top team.” Efforts are directed to get the rest of the organization to comply with the dominant coalition’s plans. This is an appropriate mode when change targets are tangible (Theory E), such as changing people, downsizing, restructuring. This is not the kind of approach that would be successful if the goal was to change beliefs or values. When change needs to be quick and produce an immediate effect, commanding approaches are appropriate. As we hinted earlier and explore more fully below, commanding interventions are almost always the initial model in DoD systems.

Engineering Interventions: tend to be focused on work processes. Re-engineering efforts, total quality efforts, socio-technical and job-design changes are engineering interventions. They include efforts to redesign business processes; efforts directed at cost, quality, service and speed are engineering interventions. Change agents tend to focus on analyzing detailed work specifications and redesigning work processes to improve quality of production. Change targets are seen as rational (motivated by economic self-interest). Change agents tend to be task analysts who diagnose work processes and organizational designs. In engineering intervention, efficiency is the most important goal.

Teaching interventions: tend to be focused on changing beliefs. This often involves teaching about ideas, values, points of view, how to motivate people, decision-making capacity, awareness of mental models, similar to what Chin and Benne called a normative-re-educative method. Efforts are made to uncover participants’ values and beliefs. Much of this work is cognition based; targets are often cognitive dysfunctions and culture change. Change agents tend to have a-priori models. (As we explore more fully below, teaching holonistic organizing principles to people in DoD organizations is a sizable challenge).

Socializing interventions: Socializing interventions pertain to changes in social relationships and involve power distribution and alterations in decision-making patterns. Examples of socializing interventions include team building and semi-autonomous work groups. The assumption here is that changes in roles and behaviors precede changes in beliefs. Following socio-technical systems theory, the assumption is that social learning processes occur mostly within groups. Most of these interventions are efforts to create semi-autonomous work groups; empowered decision-making in an effort to adapt to unpredictable environments or changing circumstances; to permit decisions to be made at the point where action is needed (as opposed to referring decisions to others who have authority but lack intimate knowledge of problems needing to be addressed). Change agents tend to be facilitators and coaches.



As we look at the effort to change from Bureaucratic to Decentralized or Holonistic organization, it is clear that this is a teleological, goal-directed change; it can be argued that all four of the intervention models above are needed. It is also important to consider what combinations and which order of intervention models should be deployed. Acquisition organizations will not change unless commanders set direction and vision, describe and communicate clearly necessity for change, determine formal organizational arrangements that should be target for change and which elements are off limits; and analyze environmental impacts (commanding intervention). Decentralized or holonistic organization will certainly involve a detailed analyses of work specifications, and a redesign in work processes (engineering interventions). Such a radical transformation will involve different beliefs, values, motivators for participants; new skills will need to be developed to aid in decision-making capabilities and team development (teaching interventions). Relational patterns and modes of interdependence will certainly be altered (socializing interventions).

Intervention Models within DoD

While all successful change efforts tend to favor one of the above models for change, they tend to require combinations of the intervention models, if not all four. The question emerges: what is the most appropriate change model for moving acquisition organization from bureaucratic to power-dispersed? The DoD usually leads with command, teaching, and engineering interventions. Unfortunately, these interventions are not up to the task of the kind of pervasive change needed to move toward edge-like structures, in which decision rights are distributed to various actors. One of the reasons that engineering interventions do not work is that they are based on quasi-rationalistic models of decision making. Such models of decision making are appropriate when goals are clear and tasks are stable. This is not the case in holonistic structures, and is not the case during transition to edge-like structures.

In order to understand how humans behave under conditions of discontinuous change and flux, we need a different model of decision-making and action. Here we review common approaches to decision-making and explore the concept of sense-making. We argue that what sense-making theories allow us to see is how people attempt to create meaning and order out of equivocal experiences; sense-making processes involve retrospective efforts, involve social processes, and depend upon notions of identity maintenance and construction. Because edge-like transformations are radical and will require multiple efforts of sense-making, we then ask an important question: what is the best intervention to enhance sense-making capacity in a way that guides actors to act in edge-like manner? We argue that skills in sense-making processes are best developed and managed within the context of socialization interventions.

In this section, we argue that the proper “order” of change interventions should be: commanding, teaching, socialization, and finally, engineering. The most important part of our argument is the proposal that socialization is a necessary mode of intervention because of the depth and pervasiveness of change and sense-making necessary to become an edge-like organization. We also demonstrate that a change process using socialization methods, while most promising, is also more costly in terms of time and resources.

Traditional models of interventions in DoD organizations: Here we discuss the traditional model of change intervention utilized in DoD efforts. Most change interventions within the DoD begin with commanding interventions and are followed by teaching and engineering interventions. Recall that command interventions are changes in structure. In



DoD organizations, leaders frequently announce changes in organizational structure, changes in reporting relationships. For example, in 2003, DoN created the Force Fleet Command—a new reporting relationship in which Pac Fleet and Lant Fleet are to report to one unified command. The intervention strategy was familiar. A small group of experts and leaders gathered to create a “concept of operations,” essentially a logic for operating under a new command structure. They released the order; new jobs were created, new reporting relationships instituted, new career structures (there is an additional job for a four star admiral in the fleet) initiated. It is questionable whether such re-organizations are discontinuous change interventions that change the identity of the organization. It is also unlikely that many work processes change.

When DoD seeks to institute changes in work practices, a similar intervention model is employed, beginning with command interventions from the top. For example, recently the Sea Enterprise initiative was announced. It began with a change in structure—a three star Admiral position was created; two commands were united. And then teaching interventions were instituted. In this case, the Admiral and his group of colleagues began to issue command “briefs,” a series of PowerPoint slides outlining the logic for “effects-based organizing,” a model of management that encourages commands to streamline processes, to cut costs, to “win the budget battle.” These efforts from the top are teaching interventions that propose new metaphors, such as “budgets are battles to be won,” cost control helps to “win the war on terror,” for example. These are then followed by engineering interventions—efforts to streamline processes. There are other familiar examples of DoD command interventions and teaching interventions followed by engineering interventions. The Total Quality Management Movement in the 80’s and the Business Process Re-engineering Movement in the 90’s provide myriad examples of such engineering interventions. It is usually the engineering interventions that count as “real” change in DoD because they are measurable; and it is here that work processes change. It is worthwhile exploring the limitations of focusing on engineering interventions when changes in identity are called for.

The problem with engineering interventions in the context of radical change:

Engineering models assume that individual decision making is rational in orientation; that problem identification is clear, that there is access to alternatives and that viable problem solutions can be attained; that decisions can be programmed, that is, that repetitive, well-defined procedures exist to find a solution to analyzable tasks. An engineering model of change tends to assume a view of people as rational, economic actors, people who have extensive information and rich frames to guide decision-making and action.

The engineering model of intervention that assumes the rational mode of decision-making is optimal when goals are clear. Rational choice models of behavior and engineering-focused interventions are appropriate when evaluating problems in relation to stable goals, when actions are chosen from various sets of alternatives. Accurate information and accurate perception are especially important in these models for evaluating the feasibility of alternatives. However, a DoD organization moving toward an edge model does not fit this conception; goals are emergent and transient. We are more likely to encounter an amorphous flux of activity that must be bracketed as meaningful and relevant before any action alternatives emerge. Further, we imagine that managers in edge climates will be faced with several problems, interpretations, action scenarios simultaneously. In these conditions, accuracy of perception might not be as important as creating a credible



interpretation or narrative. What's needed is the capacity to make sense of situations in a way that coordinates action and moves the organization forward in desired ways.

The point here is that engineering interventions, legitimized by rational and analytic tools, are appropriate only after change to an edge-like climate has occurred. During the process of transition, engineering methods are likely to escalate commitment to an undesired course of action and “refreeze” behavior too soon.

Efforts to modify rational decision making models—the Carnegie Model:

There have been several attempts to modify the rational decision making model, in particular the March and Simon, or Carnegie model. March and Simon challenged this model of decision making—most situations in organizations are non-programmed; that is, situations are novel, poorly defined, and no procedure exists for finding a solution. This “bounded rationality” perspective assumes that people have limited time, information, and resources, that organizational and social constraints limit the potential for fully rational solutions. The Carnegie model of decision making assumes that constraints create conditions of bounded rationality, that there is usually disagreement about goals and priorities, that decision making is political, that managers form coalitions and, through political processes, arrive at goals and priorities; and satisfice (that is, look around for quick solutions in the immediate, local environment rather than searching for the optimal solution) rather than optimize.

The March and Simon framework emphasizes habit in explaining choice-making and behaviors. This helps to explain the persistence of behaviors and routines, but does not address the initiation of new behaviors. It helps to explain when and how engineering interventions are appropriate, too. But because such a bounded rationality model does not focus on the process that surrounds bounded rationality, it is not useful for understanding the dynamics of radical change, for understanding how people adjust to radically changing circumstances. Also, it is limited to individual frames of reference, and does not account for the process by which choices are considered and made. This would require accounting for the larger social processes. Hence, although the bounded rationality model reflects improvement over the engineering approach that is common to DoD change, it too is inadequate in helping us understand the kinds of change required to transform into Edge-like, Holonistic organizations. To better understand how people respond to change within the context of social groups, we must turn to the model of sense-making.

Sense Making as a Tool to Understand Change Processes

One heuristic for understanding human behavior when actors are thrown into the flux of everyday events, making sense of changing context, is to explore the concept of sense-making. Sense-making refers to how people structure the unknown and is a useful framework for making sense of organizational change (Mills, 2003). Following Weick, “people make sense of things by seeing a world on which they have already imposed what they believe.” Sense-making is not a body of theory, but a recipe for analysis (Weick, 1995), a site where people construct meaning, constrain action, and construct identity.

Sense-making is explicit and “visible” under conditions of surprise and unmet expectations, when events are perceived to be different from what was expected; or when the meaning of events is so unclear that actors do not know how to engage the world. In these moments, there is a shift from what Heidegger called the “ready to hand” mode, in



which one is coping or immersed in the flow of events, to the “unready to hand mode,” in which action is disrupted and people must reflect or introspect to access reasons for engaging. The scripts and rationales that people look for in attempting to re-engage the world are drawn from organizational and institutional settings, past routines, plans and procedures. Following Mills, a sense-making framework “can be used to explain how/why particular change programmes are adopted in the face of evidence of their shortcomings, and why, despite every effort, some managers unilaterally reject such attempts at change” (p. 50). One of the reasons that a sense-making framework is useful in this project is that we are seeking to understand how acquisition professionals will act under proposals for radical change. Sense-making theory proposes that they will draw upon organizational settings and past routines, familiar plans and procedures to make sense of novel stimuli as a way to move forward. It is a useful framework to understand how knowledge unfolds piecemeal as people attempt to coordinate and circulate information.

For our purposes, we would like to draw out two of the essential properties of sense-making—identity construction and the social nature of sense-making. Within the ongoing stream of activity, people begin to notice and bracket; they carve cues from an undifferentiated flux. Bracketing and labeling are forms of simplification. Imposing labels trigger a particular kind of diagnostic treatment and will suggest modes of acting, managing, coordinating, etc. What is important for our purposes is to highlight that the way events are first envisioned begins the process: noticing, bracketing and labeling are efforts to reduce uncertainty and transience and begin to create order out of chaos; once events are bracketed and labeled, people are disposed to find ways to act. Following Weick et al. (2005):

In the context of everyday life, when people confront something unintelligible and ask “what’s the story here?” their question has the force of bringing an event into existence. When people then ask “What do I do?” this question has the force of bringing meaning into existence, meaning that they hope is stable enough for them to act into the future, continue to act, and to have the sense that they remain in touch with the continuing flow of experience. (p. 410)

Most situations are routine and do not demand explicit sense-making or full attention. Under conditions of habit and routine, people rely upon prototypic cases, encouraging stable action. When in peripheral cases arise that are equivocal, however, action becomes indeterminate and variable, candidates to change organization and adaptive patterns, and sense-making efforts are engaged. People attempt to grasp fleeting meaning, continually revising an emerging story that gradually becomes comprehensive enough that it persists and is available as resource for people to draw on in future sense-making efforts. What’s important is to create and retain plausible stories. In DoD interventions, when people face uncertainty and look around for meaningful guides, they are likely to revert to familiar recipes and scripts that are consistent with bureaucratic and mechanistic routines, patterns that would undo edge-like ideals.

Also, in the DoD there may be a tendency for people to speak as if they are trying to get the story “right,” perceiving events accurately (and in this case, perhaps interpreting the accuracy of legal constraints). However, sense-making efforts are not about discovering the “truth,” for *truth* is constructed socially within most of the social domain associated with organizational change. Although asserting and obtaining agreement on some common version of “truth” may be an important factor for motivation, this approach fails to acknowledge the social construction of organizational reality, which rarely results in a



common construction. Rather, sense-making efforts seek to create a *plausible story* (Weick et al., 2005). It is through such plausible stories that people interpret their environment, and the stories themselves become “truth”—often only implicitly—via social construction and agreement. Stories will be more plausible, especially in the early stages, when they link with prior stories, when events can be seen as exemplars of familiar principles and stories. Further, as these stories facilitate ongoing action, they become increasingly plausible. Hence, the process builds upon itself, until a large-scale organizational reality has been created through successive accretion of linked, plausible stories for making sense.

The notion that sense-making is directed toward plausibility rather than accuracy (Weick, 1995) conflicts with many academic theories, as well as the culture of the DoD. When attempting change in this case, it's important to realize that the climate of the DoD will be geared toward accuracy. Therefore, we would expect many of the early attempts at sense-making to be framed in terms of “correctness” and “accurate behaviors.” Even though edge organizations offer multiple variants of possible behaviors, few of them can be deemed “accurate” in advance of execution. Hence, accuracy as a driver for choice and behavior is a goal consistent with rational choice versions of human behavior, and we would expect this to assume a more salient theme during the engineering stage of change intervention. Alternatively, in the shorter-term phases of change toward Holonistic organizations, it's important to appreciate that plausible stories keep things moving. This is why we argue below that large group interventions (LGI) are appropriate for holonistic change. LGIs suspend routine solutions and encourage a proliferation of various narratives which then become candidates for plausible meaning-making long enough to guide actions, which in turn reinforce plausibility.

Disruption triggers and identity construction:

We examine now disruptions as triggers for sense-making. Since sense-making is the continual search for, and creation of, meaning and identity, we would expect to find explicit efforts at sense-making when the perceived world is significantly different from “world as expected.” Two types of sense-making occasions common to organization are ambiguity and uncertainty. The “shock” in each case is somewhat different. In the case of ambiguity, people engage in sense-making because they are confused by too many interpretations; whereas in the case of uncertainty, they do so because they are ignorant of any interpretations (Weick, 1995, pp. 91-92). We assume for purposes of the present study that DoD professionals will be working and acting under conditions of uncertainty, unclear of interpretations, and will search for various scripts and familiar narratives to make sense of events. They will draw upon past stories, past routines and institutionalized scripts to make sense of these aberrant events. One goal, then, of such interventions is to shift from uncertainty to ambiguity to create multiple narratives as guides to action.

Now we are equipped to examine identity construction. Identity construction is at the base of sense-making activities and undergirds the efforts to stabilize meaning: sense-makers are preoccupied with identity construction. Following Weick, “people learn about their identities by projecting them into an environment and observing the consequences” (Weick, 1995). Shocks that threaten identity trigger attempts to construct a stable, positive, efficacious identity. When people confront an unexpected situation, such as the prospect of changing from bureaucratic to “edge-like,” this will translate into identity questions; people will wonder who they are and what matters. As they act, they are likely to notice cues and triggers that enhance a sense of self efficacy. These stories help to frame the way people will commit to streams of actions.



Regarding social dynamics and sense-making, highlighting individual identity risks ignoring the social-relational nature of sense-making. Sense-making is a social activity. When unfamiliar contexts arise, people are likely to ask themselves whether the new situation is the same or different than prior situations. Multiple possible meanings become occasions for diagnosis and action strategies, attempts to reduce equivocality by seeking shared understanding. Actors will be faced with a dilemma of too many or too few possible meanings, and are likely to attend to how others frame, interpret, diagnose, and act.

As action unfolds, people's hunches become enmeshed with the task of seeking one another out for advice, looking for specialists to confirm an interpretation or to take action. Shared understandings of the "correct" action to take emerges through continual, iterative talk. Both talk and action are central to sense-making. Action creates more information and opportunities for negotiation and opportunities to increase one's sense of what is going on. Actions enable people to assess causal beliefs that subsequently lead to new actions undertaken to test the newly asserted relationships. Over time, as supporting evidence mounts, significant changes in beliefs and actions evolve (Weick et al., 2005, p. 416).

People will be testing hunches, experimenting, acting on "as if" beliefs, linking the concrete and personal with the abstract and impersonal. The question about what to do next will be linked to resistance as there is temptation to repeat familiar scripts. Scott (2003) maintains that organizations cannot be properly understood separate from their wider social and cultural contexts. Then, perhaps, if we were to understand the change process within this context, we would need to account for wider institutional trends. What are the broader cognitive, normative and regulatory forces that impinge on actors? What agencies, professions, and interest groups do these actors confront? If no other groups within the DoD move toward edge-like structures, then these outside interpretations might trump any internal effort to re-interpret distributed decision making as effective organizing. It is probable that public discourse will aid in directing members' attention in setting agendas and framing issues in legalistic terms. Given this tendency, we are more convinced of the need for socializing interventions.

The Logic for Beginning with Socializing Interventions and Large-scale Change

Recall from above our discussion of Dunphy's components of change theory; we outline various elements of change. In the case of DoD acquisition organizations, we argue that we must appreciate the nature of the task and how it is likely to change. Under bureaucratic and legalistic norms, tasks are structured sequentially. Sequential interdependence requires minimal interaction. Actors can research procedures and rules with minimal need for interpretation. Re-allocating decision rights under holonistic norms of self organizing has implications for the structure of tasks. Under these conditions, we would expect more equivocality in acquisition requests, the need for more interpretation in order to attain understanding in considering action choices, and also social processes to understand consequences of action. Rules and regulations will no longer serve as the primary or exclusive form of constraint. Actors will negotiate meaning (and perhaps resources). In short, the tasks themselves will move from sequential to reciprocal interdependence. There will be greater need for scheduled and unscheduled meetings. Meetings and exchanges will not necessarily lead to clear decisions and actions, but will likely require further negotiation and meetings. Further, since actors will now live with repercussions of their own decisions, learning needs to continue to occur after a decision is made. Decision-makers will do more research and inquiry into short- and long-term consequences of decisions. Cultural norms and beliefs will gradually become guides for action. New norms of responsibility will develop.



There will be a temptation for actors to become more risk averse as personal responsibility increases and as the need for informed decisions based on well-grounded interpretation increases. In short, changing from mechanistic to holonistic forms of organizing is a disruption of several components; new forms of social relationships are required that involve participation and negotiation of multiple stakeholders to engage in sense-making activities. One socialization intervention that seems appropriate is the large group intervention. We now discuss the nature of large group interventions and discuss one in particular—the appreciative inquiry summit.

One of the most promising recent advances in the field of organizational development and change is the area of large-scale change. Traditional change techniques have focused on work with individuals and small groups. The field has moved to focus from micro organizational issues to macro, large-system issues. (In attempting major, second-order change of the type we are discussing here, it is questionable whether working at the small-group level can accomplish much).

A range of techniques and methods have evolved over the last decade, including search conference, future search, real-time strategic change, Simu-Real, whole-system design, fast-cycle full participation and appreciative inquiry summits. What these methods have in common is the focus on large groups of people simultaneously strategizing and creating change plans. Most of these methods assume that participants can shape and decide upon issues in the organization and its environment; most include a majority of organizational members and stakeholders. These methods are highly participative; divergent voices are included. Techniques are designed to help the organization be responsive and adaptive by providing ways to get the entire system to dialogue about the organizational situation and context. Dialogue between members leads to reframing; efforts are made to search for agreement for action strategies and cooperative effort to accomplish agreed-upon goals. These techniques promise to implement change with greater speed than traditional techniques. In most of these models, change agents/consultants act as facilitators. The appreciative inquiry summit is one large-scale change intervention and follows Weisbord's (1992) dictum to "get the whole system in the room."

The Appreciative Inquiry Summit involves a broad range of internal and external stakeholders in the process. It involves commanding interventions and a steering committee to name the strategic topic that focuses the change efforts. In the case of transforming a DoD acquisition organization, we would assume that the strategic topic would need to account for customer requirements in terms of speed and efficiency; the need to empower workers at all levels to respond to customer needs with a minimum of regulatory requirements. Since the goal is to involve the entire system if possible, numerous stakeholders would be invited—including suppliers, customers, representatives from every rank and function (relationship intervention).

It typically begins with a single event or series of events (usually 3-5 days in length) that bring people together to: 1) discover the organization or community's core competencies and strengths; 2) envision opportunities for positive change; 3) design the desired changes into the organization or community's systems, structures, strategies, and culture; and 4) implement and sustain the changes and make them work through changes in work processes (engineering interventions). AI Summits range from 30 to 3000 people and can include more using online technology. Because of the power of wholeness and democratic self-organizing, the closer Summits get to including every member of the system, the more dramatic and sustainable the impact.



Advocates of summits claim that they tend to engender commitment and follow through. Summits are designed to maximize wholeness, strategic visioning, learning, and relating. They require large, arena-type spaces with groups of eight to ten diverse participants. Everyone helps address tasks while taking responsibility for their own utterances, actions, perceptions, and feelings. Members do not stay in the same groups for the entire summit, but assemble into various stakeholder groups—departmental groupings, customers, suppliers, and others. Although each AI Summit is unique, all are designed to flow through the appreciative inquiry 4-D cycle of discovery, dream, design, and destiny.

Day 1: Discovery—discovering and connecting the many facets of the organization's "positive core": the strengths, assets, competencies, capabilities, values, traditions, wisdoms, and potentials that fuel and sustain its success.

Day 2: Dream—envisioning the organization's future in bold and specific terms.

Day 3: Design—designing the "social architecture" (e.g., strategies, structures, systems, culture, processes, partnerships) to give form to members' dreams.

Day 4: Destiny—planning for action and change in work processes. Individual commitments are made, innovation teams formed, strategic initiatives launched, and large-group dialogue promotes organizational alignment. Additionally, the next steps in the change process are launched. Essentially, these are engineering interventions.

Large group interventions (specifically AI summits) are good enablers for major change required to move to holonistic organizations because they: increase facility in sense-making by providing opportunities for divergent stakeholders to share perspectives, suspend habitual recipes for actions, invite various narratives and scenarios that become candidates for plausible guides for actions, invite people to experiment with new actions, provide positive images for possible action, encourage an action orientation so that people can begin with action first (followed by belief and understanding), encourage people to make public commitments to new actions making it harder to revert to previous comfortable patterns, create arenas for people to discover areas of agreement rather than replay old conflicts, invite people to take a holistic, systemic perspective so that sub-optimization is discouraged.

The large group intervention is an appropriate model for change because: 1) it models edge-like organizational structures of guided autonomy within a controlled space; 2) it invites multiple stakeholders and voices, including voices exogenous to the organization (such as customers) to jointly create narratives, meaning, and consider identity transformation; 3) the joint meaning and definitions that emerge from large group interventions become the ground from which engineering interventions then become appropriate; 4) LGIs build on the positive and invite sense-making that builds on the positive factors in the past and facilitates possible actions into the future.

Computational Experimentation

The first step in developing computational models of the change process is ontological: members must identify what aspects of the world will exist representationally in the model. The VDT modeling suite comes equipped with an explicit representational ontology, so this step becomes more one of mapping than of creation. Specifically, we map the kinds of organizational and processual considerations discussed above onto the VDT



modeling suite. The key comparison we seek to examine through computational models is between the kinds of command- and engineering-first approaches to change—which we note above are common in the DoD—and the kinds of socialization-first approach instantiated through large group interventions. The former falls relatively close to the types of organizations and processes that have been modeled to date via VDT, so we begin there. We leave models of the latter to our future research agenda. Here, we describe a preliminary model of one change process described above: command-first change. We then discuss some insightful manipulations of this model, and close with comments linking back to the findings above.

Command-First Model

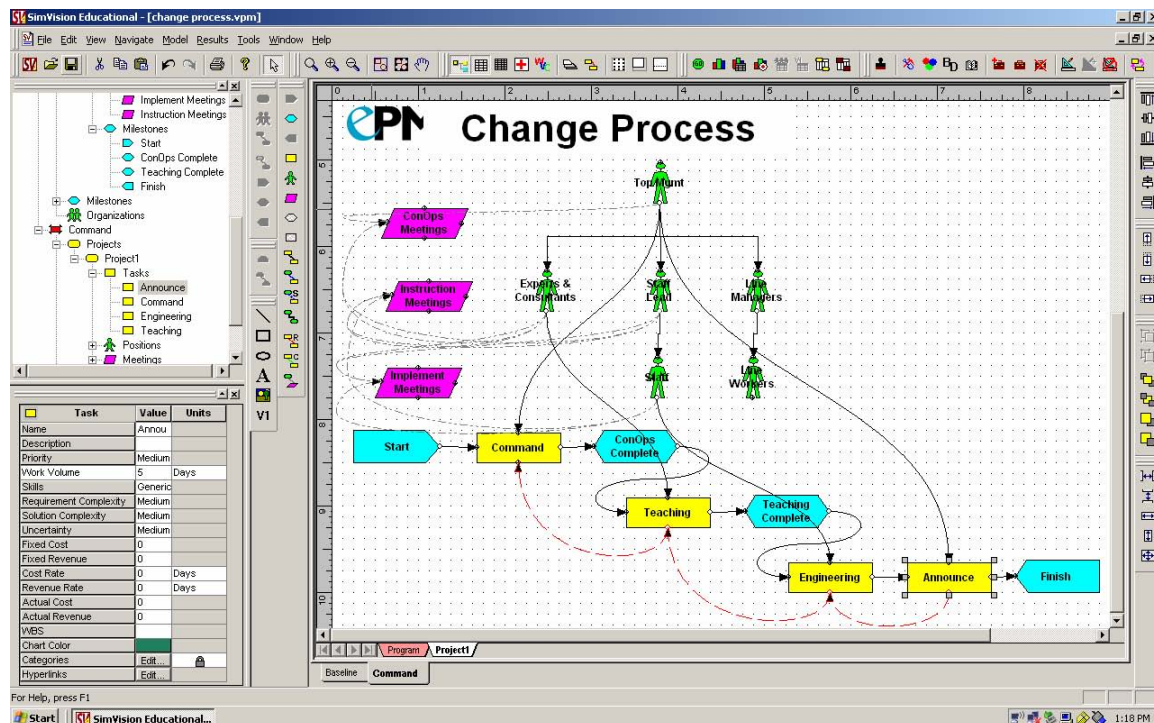


Figure 3. SimVision Change Process Diagram

Figure 1 delineates a screendump from SimVision, a commercial implementation of the VDT modeling tool set, which depicts the organizational structure and task structure associated with a command-first change process. The green person icons represent the organization structure, with Top Management at the top. In the case of acquisition organizations, Top Management would likely consist of the Service Acquisition Executive (SAE) and multiple Program Executive Officers (PEOs). In this model, we include four PEOs to work as a top-management team with the SAE. Although these leaders have considerable skill and application experience in *acquisition*, we presume that their skill and application experience in *large scale change* is minimal. Alternatively, reporting to this top-management team is a small team of (5) experts and consultants with comparatively high skill and application experience in *large scale change*. Such experts and consultants are brought in for their change-management expertise, and they serve to drive much of the change effort. Reporting to this top-management team also is a Staff Lead, who is in charge of a relatively small team of (10) workers who perform most of the considerable staff work associated with the change process. A team of (10) line-project managers report to the top-

management team also, but their focus is on day-to-day, operational project activities, not the change process per se. We include them here for reference, along with a relatively large team of (1000) project workers, who likewise focus on operational activities, not process change. In this scheme, the hierarchical lines of authority also depict the lines of communication and decision-making for the change process.

The yellow boxes depict work activities associated with the change process. We include four activities—command, teaching, engineering and announcement—arranged sequentially, and interspersed between two milestone events—ConOps Complete and Teaching Complete—that denote both progress and transition between phases of the change process. For instance, the Teaching activity does not begin until after the Command activity is complete, the latter of which is signaled by the ConOps Complete milestone. Likewise, the Engineering activity does not begin until after the Teaching activity is complete and the Teaching Complete milestone is reached. The Announcement activity follows completion of the Engineering activity in turn, and represents the final activity before the change process is (deemed) complete.

Each activity is specified with a value for *work volume*, which quantifies the level of effort required generally for adequately skilled actors to complete. The values specified for the four activities are 50, 50, 1000 and 5 person-days, respectively. In the case of Command, for instance, the 50 person-days would be accomplished by a team of five, competent, Top Management actors in roughly ten workdays (i.e., 50 person-days divided by 5 actors equals 10 days). The same applies to the other activities. The red links between the activities depict rework. As exceptions are encountered with the Teaching activity, for instance, this implies that some aspects (roughly 10%) of the Command activity must be redone. It is likewise the case for exceptions encountered in the Engineering and Announcement activities, which impact Teaching and Engineering, respectively. Dark-blue lines from the actors to the activities depict primary task responsibilities, and, hence, link the organization structure with the task structure.

The three magenta trapezoid shapes depict standing meetings that require participation by various organizational actors over specified periods of time. First, the ConOps Meetings take place two hours each week—and involve Top Management, Experts & Consultants and Staff Lead—from project start through the end of Command activities (i.e., the ConOps Complete milestone). These meetings are driven by Top Management and focus on the nature of change envisioned for the organization; participation is limited to this relatively small team of senior leaders and staff members.

Second, the Instruction Meetings take place two hours each day from ConOps Complete through the end of Teaching activities (i.e., the Teaching Complete milestone). These meetings are driven by Experts & Consultants and focus on how to transform the organization; participation is limited to Experts, Consultants, Staff Lead and Staff. Third, the Implementation Meetings take place two hours each week from Teaching Complete through the end of Engineering and Announcement activities (i.e., the Finish milestone). These meetings are driven by Staff and focus on redesigning the organization's work processes in detail; participation is limited to Experts, Consultants, Staff Lead and Staff. Notice that Line Managers and Workers do not get involved directly in this change process. However, their various organizations are represented by temporary membership on the Staff involved with the change process. This model provides us with the ability to examine and specify the change organization in considerable detail.



This model provides us also with the ability to simulate the performance of this change organization across an array of measures. A select set of performance measures and simulated values is summarized in Table 2 for this command-first model of change. The duration measure (350 days) quantifies the elapsed time for completion of the change process activities that are depicted in the model. Hence, our performance emulation suggests that nearly one calendar year would be required for the four activities represented in this command-first change process. Notice this excludes the subsequent time and effort required for the organization itself to change; that is, here we model the process of *planning for change*, but we exclude the process of *implementing change*, the latter of which will likely dwarf the former in terms of time, cost and risk. It remains for future research to develop such latter model, as we can take only one step at a time in this exploratory effort.

Table 9. Simulated Performance

Measure	Command
Duration	350 days
Cost	\$245K
Work Volume	1105 P-days
Rework	298 P-days
Coordination	275 P-days
Wait	16 P-days
Project Risk	.343
Backlog	11 days (Staff)

The cost measure (\$245K) indicates that roughly a quarter million dollars would be required to complete this change process. This figure is likely to be biased low, but we would need to calibrate the model to compensate in an informed manner. Such calibration remains for future research also. But even before calibration, because costs are simulated in the same way across different models, we would be able to evaluate comparative costs between alternate change processes (e.g., change-first vs. socialization-first). The same applies to all simulated performance measures. Indeed, the computational model enables precise control over which specific variables are changed between any one model and another, so comparative performance measures such as duration and cost can be very informative.

The next four measures listed in the table all have the same units of person-days (P-days), which represent the number of actors multiplied by the number of days they are involved in an activity. For instance, if ten actors work for one day on a particular task, this would represent 10 P-days. As noted above, Work Volume represents the amount of effort that would be required by adequately competent actors performing all of the change-process activities. The 1105 P-days indicate nearly three person-years of effort, and all values (e.g., Duration, Work Volume, others) exclude time off for evenings, weekends, holidays and other

planned non-working periods. The Rework measure quantifies the level of work associated with correcting problems caused by exceptions. At 298 P-days, Rework amounts to more than a quarter of the Work Volume. Coordination pertains to time and effort required to plan, interact and monitor the change process, which includes time spent in meetings, asking questions, and providing answers. At 275 P-days, the coordination effort is sizeable, nearly equaling that of Rework, and indicating that coordination amounts to nearly a quarter of the Work Volume. The Wait measure estimates the time spent by subordinates waiting for superiors to make decisions and provide guidance and answers that are needed. At 16 P-days, workers do not spend very much time waiting, comparatively.

Project risk assesses the fraction of exceptions that are not addressed completely or not addressed at all. Clearly not all project exceptions need to be addressed, but the more exceptions that are left unaddressed, or are unaddressed completely, the greater the chance of a major issue afflicting the change process. Hence, this measure quantifies the relative effort that would have to be expended—over and above that contributing to the work, coordination, cost and duration discussed above—to remedy all of the exceptions encountered through the change process. The value (0.343) is substantial but not uncommon. Were we to include change-process implementation in addition to the planning effort above, this value would increase appreciably no doubt. Finally, Backlog measures the maximum number of days' work queued up in the in-box of a particular actor. The 11 days shown in the table (for the Staff actor) indicates that the change-process staff fall 11 days behind at the highest point (during the Engineering activities). Backlog can be an excellent predictor of project exceptions and risk, as it highlights bottlenecks in the process.

Although such performance measures have some merit on their own (they reveal a diversity of performance aspects associated with the modeled change process), their principal value derives from *comparison* between alternate change processes. For instance, when we develop a model of the change process associated with large group intervention (e.g., Appreciative Inquiry Summit), we will be able to compare its relative performance with that of the command-first model across this array of dependent variables. This remains for future research as well.

Insightful Manipulations

The VDT modeling tool set implemented via SimVision includes nearly a hundred different parameters—each driven by Organization Theory and validated empirically—which can be varied to specify different organizations and environments. We discuss two here that offer insight into how changes in organizational climate and environment can affect performance of the change process: 1) noise and 2) experience.

First, the Noise parameter captures effects of the organizational environment that are associated with interruptions. Such effects can include unsolicited telephone calls, informational requests from co-workers, non-job-related conversations, requirements to attend meetings outside the task focus of actors, demands to perform activities that draw actors away from their primary project tasks, travel periods and like factors, in addition to organizational difficulties in terms of communications (e.g., unclear, equivocal, or conflicting directions). A change organization that is relatively “quiet” would have a lower noise parameter setting than one that is relatively “loud,” for instance. The setting for our command-first organization described above is 0.2, which represents the kind of relatively hectic and equivocal organizational environment associated generally with an *acquisition* organization, but it may be entirely too low for the kind of *change* organization modeled



here, particularly if the organization does not undergo transformational change frequently. Hence, we specify a higher noise level of 0.4 to provide insight into the effect of noise. Table 3 includes a third column to summarize the noise effect and provides the values from Table 2 above for direct comparison. All other aspects of the model delineated in Figure 1 and summarized in Table 2 above remain unchanged.

Table 10. Noise & Knowledge Effects

Measure	Command	Noise	Experience
Duration	350 days	354 days	303 days
Cost	\$245K	\$250K	\$208K
Work Volume	1105 P-days	1105 P-days	1105 P-days
Rework	298 P-days	360 P-days	317 P-days
Coordination	275 P-days	282 P-days	249 P-days
Wait	16 P-days	20 P-days	19 P-days
Project Risk	.343	.374	.305
Backlog	11 days (Staff)	11 days (Staff)	11 days (Staff)

Notice that most of the performance measures do not change appreciably between our baseline, command-first values summarized in Column 2 and those corresponding to the higher noise environment summarized in Column 3. Indeed, the increased noise level has negligible impact on Duration (4 additional days), Cost (\$5K), Work Volume (no impact), Coordination (7 P-days), Wait time (4 P-days) and Backlog (no impact). Alternatively, the impacts on Rework (21%) and Risk (9%) are sizeable. This provides insight into how top management can influence the work environment in a negative manner simply by allowing interruptions to grow. It provides insight also into the kinds of performance measures (e.g., rework and risk) that are relatively sensitive to noise.

Table 3 includes a fourth column also to summarize the experience effect. As above, all other aspects of the model delineated in Figure 1 and summarized in Table 2 above remain unchanged. The Application Experience parameter represents the level of experience that certain organizational actors have in a particular application domain. In this case, we modify the experience levels of the Top Management team only, increasing its Application Experience level one step, from Low to Medium. This represents the level of experience the top-management team has with organizational change, with Low reflecting minimal experience, and Medium reflecting some prior experience. This represents a top-management team that has been involved with previous change processes, in addition to possessing acquisition experience. In contrast to these top-management settings, the Experts & Consultants actors have Application Experience set to the level High across all models; this is why they are called “experts” and are hired as consultants.

As above, it is worth noting that most of the performance measures do not change appreciably between our baseline, command-first values summarized in Column 2 and those corresponding to the higher-experience actors summarized in Column 4. Alternatively,



both the Duration (303 days) and Cost (\$208K) measures are down appreciably, as are Coordination (249 P-days) and Risk (0.305). Notice also that the performance areas of change associated with increased experience (e.g., Duration, Cost, Coordination) differ from those affected by increased noise (e.g., Rework), and that experience has an effect on Risk that is opposite to that of noise (i.e., decrease to 0.305 vs. increase to 0.374). Intuitively, more knowledgeable top managers have a positive effect on the change process, and a noisier environment has a negative effect. Beyond mere intuition, however, using computational models such as this enables us to *quantify* the effects of such intuition. This can be very powerful.

Linkages to Findings

The computational model described above captures several elements from our findings in this study, and represents them in a semi-formal manner—one which makes explicit the various assumptions pertaining to the change process (e.g., number of participants, skill levels, noise and experience), and which can reproduce results reliably from one simulation to the next, regardless of who runs the model. This provides an unprecedented level of precision in terms of describing and communicating about change processes, and it enables us to both quantify and compare the relative performance of alternate approaches to change—*before committing to one approach versus another*. This offers the potential to revolutionize change management in the acquisition domain.

This computational model also draws directly from the qualitative study above, instantiating the top-down, relatively noisy, hierarchical environment described by the acquisition professionals interviewed. This provides a degree of representational validity to the model, and it provides the ability to represent computationally the kinds of factors described by acquisition professionals. The computational model draws directly from the theoretical study above also, instantiating the command-first, sequential, small-group intervention process ascribed to most DoD change processes. As above, this provides a degree of theoretical grounding to the model, and it provides the ability to represent computationally the kinds of factors described by theory.

However, some important, empirical factors (such as *risk aversion*, *change for change's sake*, and *optimism*) are not represented well by this model. Likewise, some important theoretical factors (such as *sense-making*, *identify formation* and *resistance to change*) are not represented well by this model, either. Hence, we must be selective about which factors and effects to assess via computational models, and which will require alternate means of evaluation. We must also endeavor to continue this exploratory research, perhaps enriching the ontology of the VDT tool set to represent such important empirical and theoretical factors. This provides a segue to our agenda for future research.

Conclusion

The DoD is a large, bureaucratic, rule-intensive organization that may no longer be best suited for its new environment. Building upon prior research on acquisition centralization, knowledge dynamics and organizational design, we draw upon the best knowledge and practice in change management (e.g., including Models of Planned Change, Change Typologies and Planning the Flow of intervention types, Intervention Models within DoD, Sense-making as a tool to understand change processes, and the Logic for beginning with socializing interventions and Large Scale Change), and analyze transformation from the classic Hierarchy to radical, alternate organizational forms such as the Edge-like Holonistic



organization identified through prior research as offering excellent potential to improve the performance of Defense acquisition organizations.

Such analysis focuses on the processes of change from one organizational form to another, and leads to the generation of transformational plans—involving both radical and incremental means—which can be used by acquisition leaders, practitioners and policy makers to outline steps—and leaps—required to affect fundamental organizational change. In particular, we argue how the traditional DoD, command-first, approach to change suffers from great limitations when large-scale transformation is desired, and that such large-scale transformations are required to move from the current Hierarchy to Edge-like Holonistic organizations. Alternatively, to overcome the stubborn nature of the DoD Bureaucracy and to affect the strong, persistent collective identity of acquisition professionals, different, socialization-first, large group interventions such as the Appreciative Inquiry Summit are called for. This represents a key result for the acquisition leader and policy maker: *The process of organizational change cannot be managed in the same way that the process of acquisition management is.* Change is different from acquisition. It should be no surprise that the management of change should differ from the management of acquisition.

We also build upon prior work on computational modeling and experimentation to develop models of the transformation process, and we explore such models to emulate the behavior of the alternate transformational plans noted above. By modeling and experimenting with processes of change, as opposed to processes of ongoing organizational routines, we begin to extend the state-of-the-art in computational modeling and experimentation. Although our exploratory modeling work represents only a relatively small step in this direction, we illustrate how even elusive change processes can be modeled with both representational validity and theoretical grounding, and we provide insight into the kinds of controllable factors that influence the performance of change processes: *environmental noise impedes change*, and *application experience of top managers promotes change*. Although such insight is consistent with intuition, we possess now the ability to quantify such intuition, and to compare the relative performance of myriad, diverse, alternate approaches to organizational change. This opens up a whole new way to plan and execute organizational change in acquisition.

Clearly, additional research along the lines of this investigation is called for. Additional qualitative work can uncover even deeper insights into the indicators and nature of change in acquisition, for example, and additional theoretical work can identify even more generalizable guidelines for approaching planned change. Theoretical work can also serve to guide additional qualitative studies, and qualitative work can, likewise, inform additional theoretical studies. Both qualitative and theoretical work can guide and inform additional computational modeling, and computational modeling work can both guide and inform additional qualitative and theoretical research. This integrated, three-part research approach of ours—one which places theoretical study at the fulcrum to balance qualitative fieldwork with computational experimentation—offers huge advantage in terms of triangulation, and we show already how results can inform the acquisition leader and policy maker today, as well as guide the acquisition researcher tomorrow.



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Transforming the Enterprise of Acquiring Public Sector Complex Systems

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ABSTRACT

The acquisition of public sector complex systems is time consuming, very expensive, and rife with uncertainties. The enterprise associated with acquisition is an excellent candidate for transformation—fundamental change to achieve substantially higher levels of value. This paper argues that choosing among alternative transformation initiatives should be based on an enterprise-wide perspective as well as an economic valuation of the alternative investments. An options-based methodology for assessing economic value is presented and illustrated.

INTRODUCTION

Enterprises that acquire public sector complex systems are facing serious cost challenges. Costs of military platforms (e.g., ships), space platforms (e.g., space stations) and transportation systems (e.g., airports) have increased enormously in the past few decades, far beyond inflation during this period. Consequently, the public sector enterprises that acquire these systems anticipate buying fewer systems. This tends to sacrifice needed capabilities as well as exacerbate the cost challenges.

This paper addresses the question of where resources should be invested to transform the overall acquisition enterprise and ameliorate this problem. The model of the enterprise adopted includes political entities (e.g., Congress), government agencies (e.g., the military services), contracting companies (e.g., defense contractors), workforce organizations (e.g., unions), development and construction facilities (e.g., ship yards), and suppliers to facilities. This model is illustrated in the context of military shipbuilding.

A portfolio management approach is outlined that enables understanding and balancing the returns and risks associated with alternative investments, as well as highlighting investments that dominate alternatives in terms of both returns and risks. Investments considered include rationalizing of authorization and acquisition processes, streamlining of acquisition policies and practices, accelerating bid and proposal processes, modifying work processes and procedures, redesigning incentives and reward systems and, of course, investments in improving the system itself.



BACKGROUND

To an extent, we are addressing the question of the economic value of reforming acquisition. To place our approach in context, it is valuable to understand the effects of previous reform efforts and the current state of research on the acquisition enterprise itself. Our emphasis in this section is on defense acquisition.

Acquisition Reform

The defense acquisition enterprise is unique; it operates with public funds, with primarily one buyer, little competition, contracts signed years in advance based on cost estimates, and decisions made in complex stages by multiple organizations. The process is infused with disparate goals and objectives: to have the highest performing technology at the lowest price possible in the fastest amount of time; to ensure the defense industry and related economies remain solvent; and to encourage small business, minority contractors, and women-owned businesses (Cancian, 1995). The number of participants in the acquisition enterprise is large, and each has different goals and measures of success. It seems that we cannot agree on what needs to be reformed—let alone how to fix it.

Historically, reforms have been enacted for primarily two reasons: increasing complexity of the technologies involved and individual corruption and abuse for monetary gain. Excesses in time and cost, or deficits in performance, are some of the more obvious outward signs that reform is warranted. It took 25 years from the time the Air Force identified the need for an advanced tactical fighter to replace the F-15 until the F-22 was combat-ready. During that time, defense spending cuts caused several major re-phrasings of the program, adding to the delay.

The M247 Sergeant York DIVAD (Division Air Defense gun) was born of the Army's need for a replacement for the ageing M163 20mm Vulcan A/A gun and M48 Chaparral missile system. When the first production vehicles were delivered in late 1983, there were many performance deficits, most notably the radar's inability to distinguish between a hovering helicopter and a clump of trees. This problem and others proved insurmountable and, in December 1986 (after about 50 vehicles had been produced), the entire program was terminated.

The list of acquisition regulations and initiatives is fairly lengthy but, as shown by Drezner et al. (1993), reform initiatives from 1960 to 1990 did not reduce cost growth on 197 defense programs. In fact, the average cost growth on these programs was 20% and did not change significantly for 30 years. Christensen et al. (1999) reaffirmed this conclusion and also found that initiatives based on the specific recommendations of the Packard Commission did not reduce the average cost overrun percent experienced on 269 completed defense acquisition contracts evaluated over an 8-year period (1988-1995). Actually, cost performance experienced on development contracts and on contracts managed by the Air Force worsened significantly.

These findings raise the question of whether it is possible to transform the acquisition enterprise, and to have the varied stakeholders agree to any extent that the process has actually improved. This question leads to the following brief review of the current state of acquisition research.



Acquisition Research

A quick review of recent acquisition research topics indicates a tendency to concentrate on single-issue concepts such as outsourcing, contractors, leasing, privatization, contingency contracting, performance measurement and financial management. Considering the 2004 and 2005 Annual Conferences on Acquisition Research, topics covered included:

- Acquisition avenues such as market-based acquisition, capabilities-based acquisition, competitive sourcing, and outsourcing
- Acquisition issues such as program management, performance management, and business process reengineering
- Financially oriented topics such as financial management, total cost of ownership, and real-option models

Further, acquisition policy in general was, of course, a recurring theme. While improving the performance and/or judging the effectiveness of each of these topics is worthwhile, it is also important to study the overall acquisition enterprise as an integrated and interactive complex system.

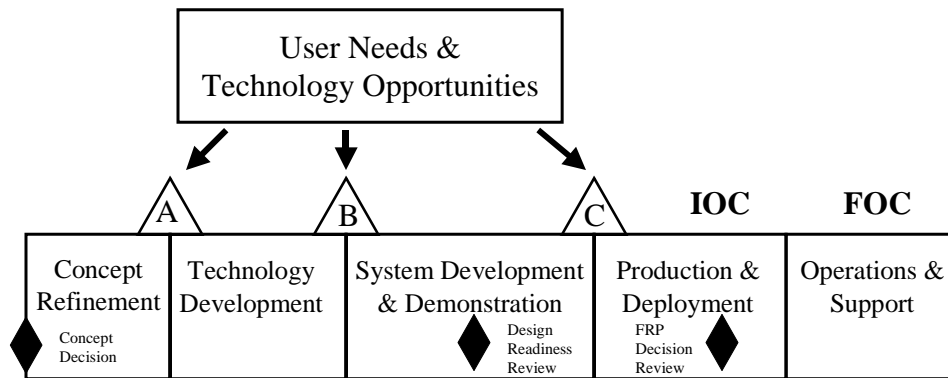
Currently, however, only extremely limited acquisition research is being conducted—primarily by internal DoD organizations, such as the Naval Postgraduate School, Defense Acquisition University, Air Force Institute of Technology, and DoD FFRDC's (e.g., RAND and LMI). Although these research projects offer valuable assessments of current practices and suggestions for improvements, the results are often limited in scope and may only address one specific problem at a time, often replicate previous or parallel work, and generally have limited general application. These efforts constitute only a fraction of the effort that is warranted by the size, complexity, and changing nature of DoD's acquisition challenges. They are not a substitute for disciplined, replicable academic research (Gansler, 2005).

Acquisition Lifecycle

Figure 1 depicts the Defense Acquisition Management Framework provided in the Defense Directive 5000.1 (DoD, 2003). This process provides both the context for transformation of acquisition and an opportunity, in itself, for transformation. In fact, the ways in which the many stakeholders in the acquisition enterprise exercise this process strongly affect the time, costs, and uncertainties associated with the acquisition of complex systems. In light of the Secretary of Defense's stated transformation priorities, this process would seem to be a good candidate for fundamental change.



Figure 1. Defense Acquisition Management Framework



THE ACQUISITION ENTERPRISE

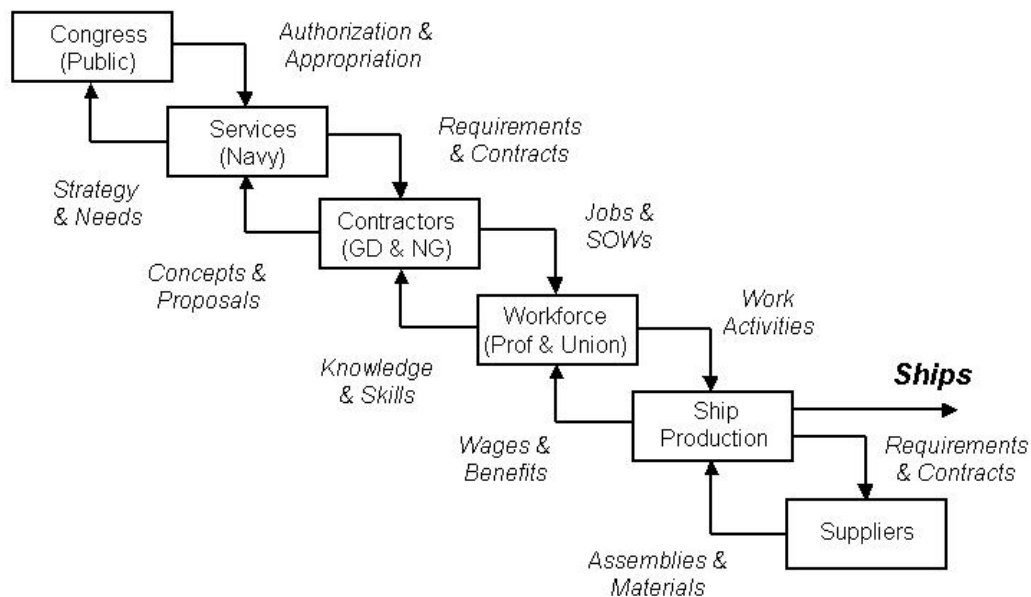
Consider the enterprise of military shipbuilding. This enterprise is facing serious cost challenges. Shipbuilding costs have increased enormously in the past three decades, far beyond inflation during this period. Consequently, customers for these ships anticipate buying fewer ships, which tends to exacerbate the cost challenges. This paper addresses the question of where resources should be invested to transform the enterprises such as shipbuilding and ameliorate these problems.

Enterprise Issues

As indicated in Figure 2, the enterprise of interest includes a set of stakeholders and issues much broader than those directly associated with the ships of interest. Congress, the services, defense contractors and workforce organizations have significant impact on the returns and risks associated with alternative investments. These stakeholders affect the ship building enterprise in a variety of ways:

- Congressional Interests & Mandates, e.g., Jobs & Other Economic Interests
- Service Interests & Oversights, e.g., Procedures, Documentation & Meetings
- Incentives & Rewards for Contractors, e.g., Cost-Plus vs. Firm Fixed-price
- Lack of Market-Based Competition, e.g., Hiring & Retention Problems
- Aging Workforce & Lack of Attraction of Jobs, e.g., Outsourcing Limitations, Underutilization of Capacity

Figure 2. The Overall Shipbuilding Enterprise



Military vs. Commercial Ships

There have, in recent years, been many studies of best commercial practices in manufacturing and assembly, e.g., Lean and Six Sigma, and attempts to adopt these practices for military shipbuilding. These initiatives have had positive impacts. However, there are important differences between military and commercial ships:

- Ship Size & Complexity—Slower Design
 - Commercial: Large & Relatively Simple
 - Military: Complex & Relatively Small
- Acquisition Process—Slower Buying
 - Commercial Simpler than Congressional/Military
- Design & Construction—Slower Production
 - Commercial: Large Steel Boxes with Simple Systems
 - Military: High Density of Integrated, Sophisticated Equipment
- Workforce Character—More Expensive People
 - Commercial: Mostly Blue-collar Workers
 - Military: Much More Engineering Support

Consequently, commercial shipbuilding “best practices” are, in many respects, inapplicable to military shipbuilding, especially for naval combatant vessels. This is not to deny that

some subset of commercial “best practices” can be transferred to military shipbuilding, but these are unlikely to dramatically reduce military shipbuilding costs.

PORTFOLIO MANAGEMENT APPROACH

We advocate a portfolio management approach to enable understanding and balancing the returns and risks associated with alternative investments, as well as highlighting investments that dominate alternatives in terms of both returns and risks. Figure 3 depicts a typical portfolio for a military weapon system.

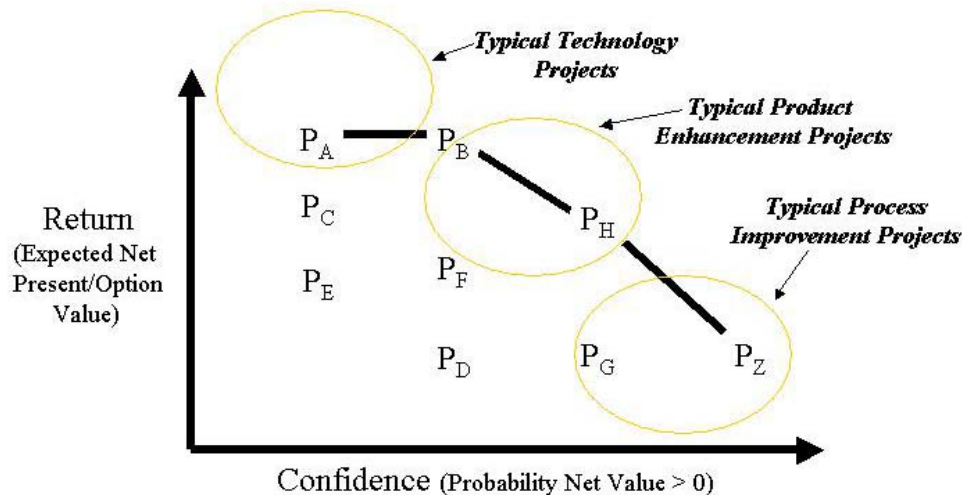


Figure 3. Example Portfolio Plot for Military Weapon System

Alternative investments, denoted by the Ps, are characterized in terms of return and risk. Return is expressed as either Net Present Value or Net Option Value, the latter being appropriate when investments are staged with intervening decision points for continued investment. Confidence (i.e., 1- Risk) is expressed in terms of the probability that Net Value exceeds some threshold, in this example zero.

The characterization of Confidence for each project enables consideration of the variability of Return for each investment. Thus, for example, P_D, P_G, and P_Z are equivalent in term of Return. If Return were the only metric, these potential investments would be equivalent. However, once Confidence is added, it is clear that P_Z is the superior investment.

Sources of Uncertainty

The importance of characterizing the variability of returns requires that we consider sources of uncertainty in the shipbuilding enterprise. Figure 4 provides an initial characterization of sources of uncertainty. Clearly, the various stakeholders outlined earlier have significant impacts on uncertainties in terms of both magnitudes and timing of returns. A portfolio management approach requires that we model these sources of uncertainty and

use this model to derive a probability distribution for savings cash flow and net value to enable characterizing Confidence for each potential investment.

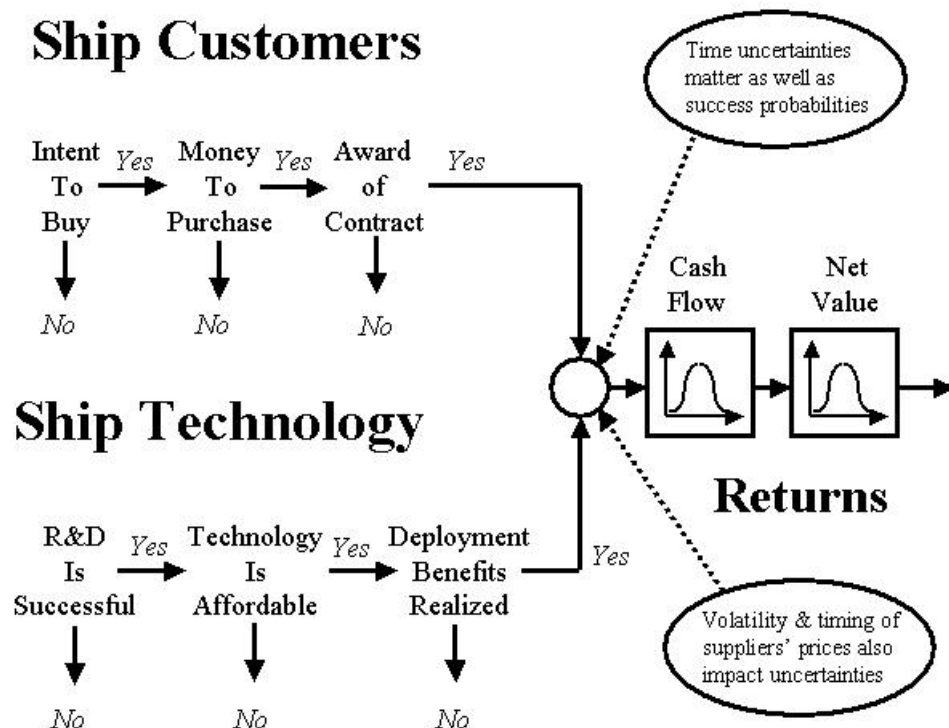


Figure 4. Sources of Uncertainty in Ship Building

Investment Valuation

When considering whether to invest in any initiative, the inevitable question arises, what is the value of that initiative? For a private-sector initiative, this question, at least in theory, has a relatively straightforward answer. The value of an initiative is the expected present value of the future cash flows. Since private firms seek to maximize their profits, such a single objective measure is not unreasonable.

The public sector is a little more complicated. Government agencies typically seek to balance multiple, competing objectives to maximize the public good. In an ideal world, one could establish a measure of public utility over the set of competing objectives, and the value of an initiative would be the utility it is expected to deliver. Since developing an explicit utility function for public good would be a highly political exercise, we will leave determining the public good to policy makers. Thus, we take the tact here that the goals of a government agency such as the DoD have been set, and the initiative we are concerned with are those that minimize the cost of achieving those goals.

Fixing the goals allows us to value monetarily what amount to process change initiatives. Given a current process for achieving a set of goals (e.g., the current DoD acquisition process in Figure 1), what savings would a process change yield? The expected present value of the cost savings would be the value of this process change. This

transforms the value of a public-sector initiative into a series of cash flows and opens the door for us to use investment valuation tools developed for private-sector investments.

Traditional Approach. The traditional measure of the value of an investment is Net Present Value (NPV). NPV is simply future cash flows (positive or negative) discounted to present value and summed. If the NPV is positive, the investment is worth the cost. In a risk-free world, NPV would be a perfectly acceptable measure, but when uncertainty is introduced, NPV tends to undervalue investments.

There are two key reasons for undervaluation. The first is that an NPV valuation assumes total commitment to an investment regardless of intermediate results. If, for example, an R&D project is found to be technically infeasible shortly after it is begun, all of the planned expenditures will be made despite the new information that has been gained. Thus, NPV does not reflect managerial flexibility to terminate investments, which is of considerable value in limiting downside risk.

If managerial flexibility reduces downside risk, it stands to reason that failing to account for it undervalues a project. One way to compensate for this shortcoming of NPV is to employ a decision tree. A decision tree can be used to account for managerial flexibility, and it produces an expected NPV that is a better measure than the traditional, deterministic NPV. Decision trees, however, do not account for the second shortcoming of NPV, which is a little more subtle.

The question always arises when calculating NPV, what is the appropriate discount rate? Traditionally, the answer is the enterprise's cost of capital (i.e., the effective interest rate at which the enterprise can borrow money) because it reflects the rate of return that investors demand from the enterprise given its level of systematic (market) risk. The problem is that the riskiness of any particular investment may not be the same as that of the overall enterprise and will change as new information is gained over the course of the project. Since investors demand different rates of returns for different levels of risk, the discount rate will change as the project progresses. In theory, the appropriate discount rates can be derived from a capital asset pricing model, but in practice this is rather difficult.

Real Options. A real-options approach accounts for both managerial flexibility and appropriate risk-adjusted discount rates. A call option is the right, but not the obligation, to buy an asset (such as shares of stock) at a pre-specified price over a pre-specified time interval. One type of call option, known as the European call option, specifies a particular date on which the option can be exercised. When the date of expiration is reached, if the price of the underlying asset is greater than the pre-specified purchase price, the option holder would want to exercise the option since the asset is worth more than its price. If, on the other hand, the price of the asset were below the pre-specified price, the option holder would, obviously, not want to exercise the option. Thus, a call option mitigates downside risk since the most that can be lost is the purchase price of the call option.

Now, consider product development. Assume that there is an initial investment to develop the product, and then a subsequent investment required to build a factory to produce the product. This investment is analogous to a call option. The initial investment buys the business the option to build a factory to produce the new product. The underlying asset is the present value of the free cash flows generated from the sales of the product. Since market conditions change over time, the value of the market for the product will also change. At the end of the development phase, if management felt that it would lose money



selling the new product, they would certainly not build the factory. If, on the other hand, the new product appears profitable, they will build the factory, i.e., exercise the option that they “bought” with their initial investment in product development (Rouse & Boff, 2004).

Black and Scholes (1973) in their seminal paper developed a closed-form equation that determines the fair price of a European call option; and subsequent researchers have developed methods to price many other types of options. The basic premise of their pricing scheme is that options draw their value from the behavior of the underlying asset. For real options, the underlying asset is the expected present value of the future cash flows that are generated from a successful implementation of an initiative. These cash flows would be subject to a variety of uncertainties, the nature of which depend on the particular domain of interest.

Now, consider process-oriented initiatives such as transformation of acquisition. For a large project, one would likely divide the project up into several stages to mitigate risk. As indicated in Figure 4, there are several kinds of risks of concern. We can, at least initially, group these uncertainties into two classes: market risk and technical risk. Market risk is the uncertainty in the final outcome of the project. For a process-change project, the savings achieved will be heavily dependent upon the prices or costs of the inputs to the process. As the prices of those inputs fluctuate, so will the value of the project. If, for example, the prices of several major inputs were to fall precipitously, it might make the effort involved to change the processes not seem worth it. Technical risk involves the uncertainty in the execution of the project. Budgets and priorities might shift, the requisite personnel might not be available, or the idea behind the process change simply might not work. Staging a project provides managerial flexibility and the ability to limit downside risk.

Each stage provides project management an option to discontinue the project. So, a multistage project could be viewed as a compound call option. The last stage is a call option on the future cash flows, but the stage before would be an option to buy the call option, and so on. It turns out that if we make certain assumptions about the variability of the underlying asset, there is analytic equation that determines the value of a compound call option (see Geske, 1979; Cassimon et al., 2004). Another approach that is more intuitive and flexible is the binomial lattice method (Luenberger, 1998; Trigeorgis, 1996).

Example. To illustrate how the real-options approach could be used to value a process-improvement project, assume that we are considering revising acquisition procedures for new weapon systems such that we reduce the cycle-time for early stage activities such as developing requirements and specifications. These are fairly manpower-intensive tasks, and, hence, we would assume that the savings from this procedural change would come as a reduction in the number of man-hours required to carry out these tasks. There are two things we need to determine: What is the value of these savings, and are the savings worth the cost of making the change? To use the real-options approach, we must first characterize the behavior of the underlying asset—in this case the present value of future savings.

For simplicity, let us assume that this is a three-stage initiative. The first stage involves studying the feasibility and implementation of the proposed reform. The second stage involves a pilot test of the revised process on an actual acquisition program, and the third stage involves implementing the new process DoD-wide. Each stage has an implementation cost, a probability of success, and an expected duration. We will assume the following notional values for the cost, probability of success, and duration of each stage.



We also assume that since the government borrows at the risk-free rate, the cost of capital or discount rate is equal to the risk-free rate.

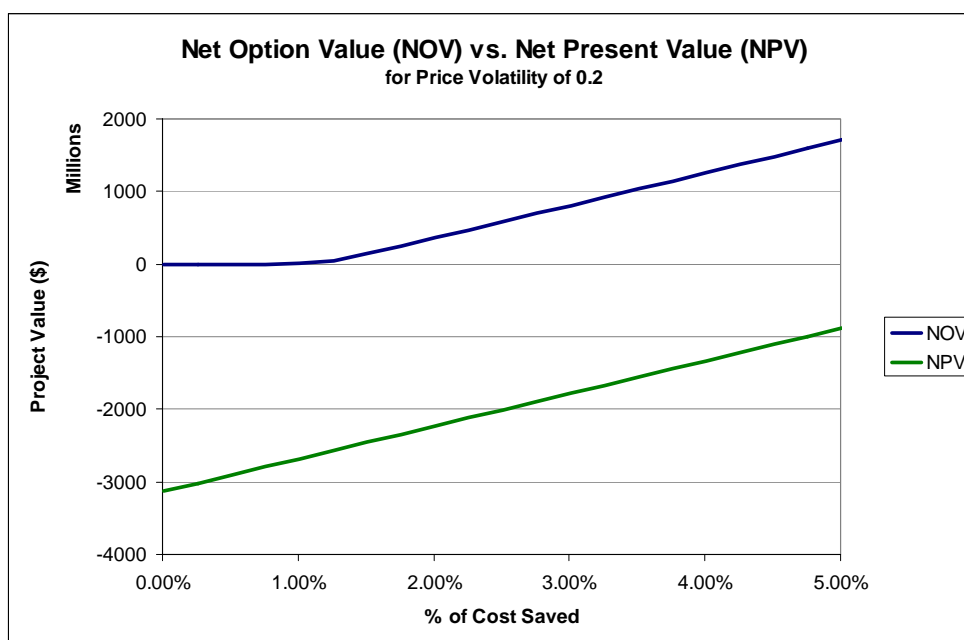
Table 1. Project Stage Parameters

Stage	Cost	P(Success)	Duration (years)
1	\$ 1,000,000.00	0.3	0.5
2	\$ 500,000,000.00	0.5	2
3	\$ 3,000,000,000.00	0.75	N/A

Note that the duration of the final stage is not relevant for this analysis because we assume that the costs and benefits are discounted to the point of decision. Since no further decisions are made after the decision to enact stage three, we are not concerned with the stochastic behavior beyond that point.

Based on a representative set of model parameters, e.g., a savings rate of 2%, we obtain a traditional expected net present value of $-\$2,236,145,664$ —an expected loss of over \$2 billion. However, this valuation does not account for managerial flexibility. When we evaluate the project as a real option using the binomial lattice method with a time step size of 0.01 years, we get a value of \$355,852,308. Thus, the project actually has an expected gain of over \$350 million. Of course, these results are for a particular rate of cost savings, i.e., 2%. As we vary the value of this parameter, we see in Figure 5 that the net option value (NOV) is always greater than the expected net present value (NPV).

Figure 5. NOV and NPV vs. Savings Rates



We see that for savings rates under about 1%, we would reject this project if we used NOV as our decision criterion. However, if we used NPV as the criterion, we would reject this project even for savings rates greater than 5%.

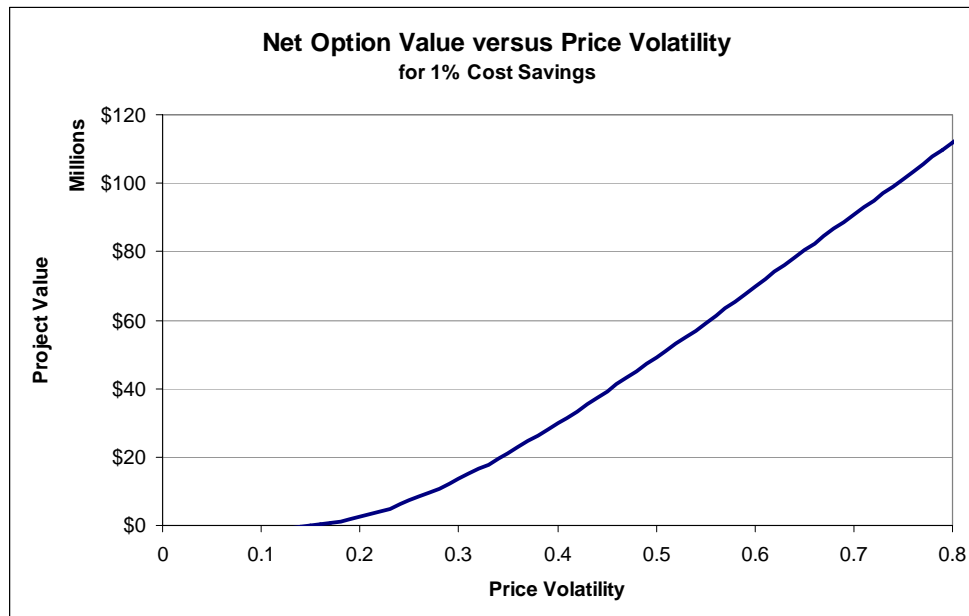
What about the uncertainties in the project outcome? It is a well-known property of options that they actually increase in value when the uncertainty increases. This is because managerial flexibility reduces downside risk while preserving upside potential. This is especially true for “borderline” projects. Figure 6 depicts the change in net option value as the log volatility of price-per-man-hour changes when the savings rate is set to 1%. Log-volatility is a measure of the uncertainty or noisiness of the price. We see that as it increases the value of the option increases.

This trend applies to technical risk as well as market risk. The real options methodology is consistent with the intuitive notion that one can undertake highly risky projects if one stages them to limit downside risk. This allows for justification of worthwhile projects that would have been rejected under a more traditional NPV analysis.

Often, one may have many such projects under consideration. If we assume that the projects are fairly independent, we would like to examine the risk-reward trade off of our portfolio. In theory, risk has been fully accounted for in the net-option value, and any other examination of risk would be a form of double counting. But the problem is that the option value calculation presumes risk neutrality on behalf of the decision makers with regard to any non-systematic (non-diversifiable) risk. The rationale behind this is that the shareholders of a firm also hold shares of many other firms, and they can diversify away any risks that are not intrinsic to the marketplace. If the managers of a firm truly serve the shareholders of a firm, then they should be risk-neutral with regard to any non-systematic risks (e.g., the failure of the project).

Of course, we know in reality that this is not really true. A manager's job may depend upon the success or failure of a project, and there may be shareholders who do not hold fully diversified portfolios (as in the case of the government). Thus, these entities are likely to be at least somewhat risk-averse. While risk neutrality is a convenient assumption for valuation purposes, it would be meaningful to a risk-averse decision maker to see some measure of the uncertainty in a project's outcome.

Figure 6. Sensitivity of NOV to Volatility in Price per Man-hour



There are several possible measures of risk with variance being the most common in a financial setting. In this case, however, we have used staging to mitigate much of the downside risk while preserving the upside risk. Since variance does not distinguish between the two, high variance in this case may actually be good. Nevertheless, most decision makers would like to know about the downside risks of a project. One possible measure of the downside risk of a project is the conditional expected value of a loss. That is, if the project does experience a loss, how big of a loss can be expected? Such a quantity can be somewhat cumbersome to determine with complicated projects, so Monte Carlo simulation was used to determine the conditional expected loss for the previous example.

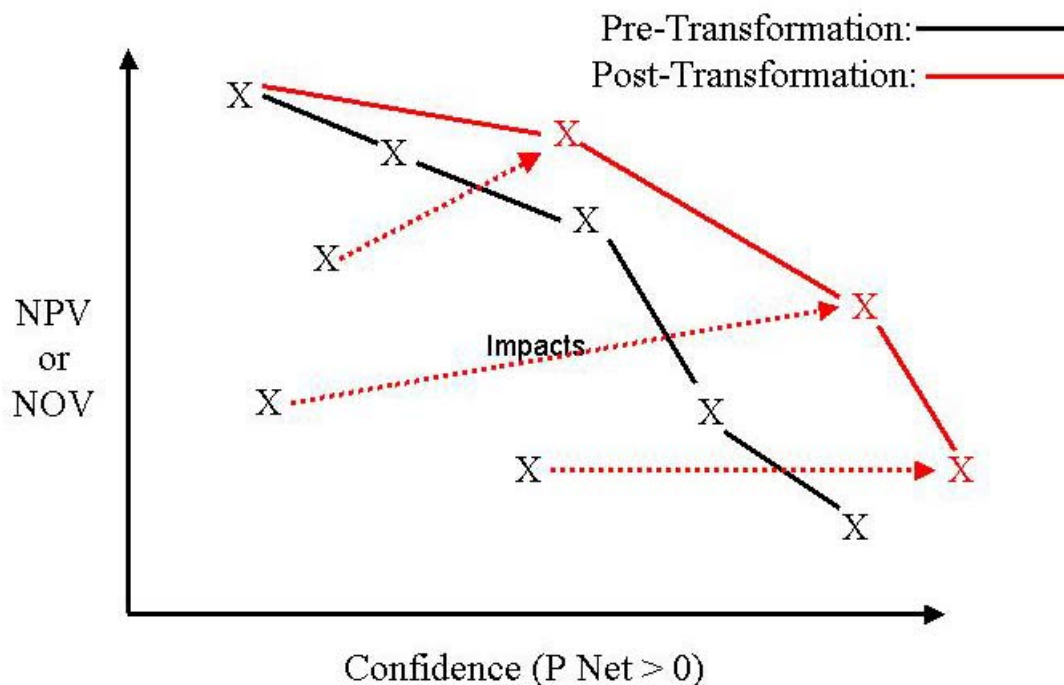
For the example project, the conditional expected loss was found to be approximately \$330 million. That means that if there were a loss, on average it would be \$330 million. Considering that the total implementation costs for the project are about \$3.5 billion, we can see the power of staging as a risk-mitigating factor. If we had a portfolio of many such projects, we could plot their net option values versus their conditional expected losses to better understand the balance between risk and reward. The result would be a portfolio plot such as Figure 3—in this case using risk rather than confidence.

ENTERPRISE TRANSFORMATION

Enterprise transformation is driven by experienced and/or expected value deficiencies and is enabled by changes of work processes (Rouse, 2005a, 2005b, 2006). By “work,” we mean any relevant activities pursued by any of the actors in Figure 2. Thus, changes might be affected in organizational processes for policy, authorization, appropriation, acquisition, development and deployment, or of technical processes for design, production, operations, maintenance, and repair. Work processes may be changed to increase returns and/or decrease risks.

In general, the type of changes just outlined will impact time, costs, and uncertainties. These impacts will, in turn, affect the timing and magnitude of expected cash flows and, hence, the NPV, NOV and Confidence associated with potential investments. A typical result, as shown in Figure 7, is that transformation affects the attractiveness of the potential investments depicted on the portfolio plot. In this example, the set of non-dominated alternatives has changed due to transformation initiatives that, in this instance, have somewhat increased return and substantially increased Confidence.

Figure 7. Characterizing Impacts of Enterprise Transformation



Thus, employing the methodology described in this paper, one can assess the economic value of alternative transformation initiatives. This is particularly important in the public sector where, in our experience, there is an abundance of transformation initiatives. Most of these initiatives make sense. However, it is difficult to choose those few initiatives deserving of major investment without some means of assessing the relative value of alternative initiatives. The methodology presented here provides such a means.

CONCLUSIONS

The acquisition of public-sector complex systems is time consuming, very expensive, and rife with uncertainties. Consequently, the enterprise associated with acquisition is an excellent candidate for transformation—fundamental changes of organizational processes for policy, authorization, appropriation, acquisition, development and deployment, or of technical processes for design, production, operations, maintenance, and repair. This paper has argued for an enterprise-wide perspective when choosing among alternative transformation initiatives.

We have also argued for economic valuation of the alternative transformation investments and presented an options-based methodology for such economic assessments. A notional example was used to illustrate the impact of this approach versus a more traditional approach. In general, traditional discounted cash flow methods very much under-value multi-stage initiatives. Options-based approaches, in contrast, enable many more early-stage investments but fewer later-stage investments, thereby not diluting resources to invest in high-payoff transformation initiatives.

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Panel – Issues in Acquisition and Public Policy

Wednesday, May 17, 2006	Issues in Acquisition and Public Policy
1:30 p.m. – 3:00 p.m.	<p>Chair:</p> <p>RDML Martin Brown, USN – Deputy Assistant Secretary of the Navy (Acquisition)</p> <p>Papers:</p> <p><i>To What Extent are DoD Activities Capitalizing on Commercial Item Designation Statutory and Regulatory Provisions under FASA, FARA, and SARA—Getting the Most from Limited Resources</i></p> <p>Cory Yoder, Naval Postgraduate School</p> <p><i>Improving Public Perceptions by Instilling Objectivity in Decisions to Waive Procurement Regulations</i></p> <p>Kenyon Potter, University of California</p> <p><i>The Use of Alternative Dispute Resolution Techniques in United States Air Force Environmental Conflicts</i></p> <p>SMSgt Nanci R. Pigeon, USAF, 609 Air Support Squadron/A4/LGC</p> <p>Lt Col Bryan J. Hudgens, USAF, Naval Postgraduate School</p> <p>Lt Col Ellen C. England, USAF, Air Force Institute of Technology</p> <p>Lt Col Leon A. Mable, USAF (ret.), Air Force Institute of Technology</p>

Chair: RDML Martin Brown, USN, Deputy Assistant Secretary of the Navy (Acquisition)

Rear Admiral Brown is the Deputy Assistant Secretary of the Navy for Acquisition Management for the Assistant Secretary of the Navy (Research, Development and Acquisition). He advises the Navy's Senior Acquisition Executive on business matters concerning Navy and Marine Corps programs and provides policy and oversight for the Navy's procurement system, which comprises over 600 activities—conducting approximately two million transactions annually worth more than \$40 billion.

Rear Adm. Brown also serves as the Competition Advocate General of the Navy. As such, he ensures that the Navy and Marine Corps maximize competition to obtain the best value for their procurements.



He previously served as Special Assistant for Joint and Operational Logistics, Naval Supply Systems Command, Arlington, VA, from 2002 to 2004. His other tours include Force Supply Officer for the Naval Surface Force, US Pacific Fleet, from 2000 to 2002, Acquisition Business Management Deputy for Program Support in ASN (RDA) from 1998 to 2000. From January to July 1999, he served in Sarajevo, Bosnia, as NATO's Theater Head of Contracts.

Rear Adm. Brown received his commission through the NROTC program from the University of Notre Dame in 1977. Following Supply Corps School, he was assigned as Supply Officer of *USS Andrew Jackson* (SSBN 619). From 1980-1982, he was a Navy Acquisition Contracting Officer at the Navy Regional Contracting Center in Long Beach, CA. From 1982 to 1984, he served as Supply Officer of Submarine Squadron Four in Charleston, NC.

From 1984 to 1986, he attended UCLA's Graduate School of Management, receiving his MBA in Finance and Public Management. From 1986 to 1989, he served as Business Review Officer and New Construction Contracts Officer at the Supervisor of Shipbuilding, Conversion and Repair in San Diego. Following that tour, he was Assistant Supply Officer of *USS McKee* (AS 41).

Rear Admiral Brown served as Deputy Director of the Missiles, Systems and Avionics Contracts Division at the Naval Air Systems Command in Washington, from 1991 to 1993. He received a Master's of Science degree from the Industrial College of the Armed Forces and also graduated from the Defense Acquisition University's Senior Acquisition Course in 1994.

From 1994 to 1996, he was assigned to the Joint Staff International Logistics Division. For his contributions to operational logistics in Haiti and Bosnia, then Commander Brown was recognized as the Logistics Directorate's Action Officer of the Year in 1996. From 1996 to 1998, he was Supply Officer of *USS Tarawa* (LHA 1), completing two western Pacific deployments.

Rear Adm. Brown's awards include the Legion of Merit, the Defense and Navy Meritorious Service Medals, the Joint Service Commendation Medal, and the Navy Commendation Medal with three gold stars.



To What Extent are DoD Activities Capitalizing on Commercial Item Designation Statutory and Regulatory Provisions under FASA, FARA, and SARA -- Getting the Most from Limited Resources

Presenter: E. Cory Yoder, Naval Postgraduate School – CDR (Ret) Cory Yoder is a faculty member of the Naval Postgraduate School's Graduate School of Business and Public Policy (GSBPP). Assigned to NPS in July 2000, he accepted an appointment as Academic Associate (Program Manager) for the 815 (MBA) and 835 (MSCM) programs in December 2002. CDR (Ret) Yoder was recruited, accepted and is serving at NPS/GSBPP as Lecturer and Academic Associate (Program Manager); a position he has held since May 2004. CDR (Ret) Yoder has strong acquisition and contracting experience, combined with several challenging acquisition, logistics, industrial, headquarter, and combat support operations assignments.

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Overview:

Premise, objectives, significance, and relevance to NPS, DoN and DoD, and other pertinent information:

Premise: The past decade has seen a significant change in business practices within the Federal contracting arena. The changes have created a more business-to-business like contracting methodology, via commercial item designation streamlined procedures, for the conduct of Federal procurements meeting specific criteria defined in statutory authority provided under the Federal Acquisition Streamlining Act (FASA), the Federal Acquisition Reform Act (FARA), and the Services Acquisition Reform Act (SARA). The aforementioned legislation allows for the utilization of Simplified Acquisition Procedures for all commercial item designated goods and services up to and including \$5 million. The legislation was passed in order to improve the efficiency and effectiveness of Federal contracting processes. However, based on informal review of the business decision protocol at many acquisition and contracting centers, and as a result of similar research conducted in the Fall of 2004, contracting activities may not be effectively utilizing the legislative authority to garner efficiencies and effective service provision that may be possible under the new legislation.

Objective: The objective is to determine the extent to which DoD activities are capitalizing on the legislative provisions of FARA, FASA, and SARA, and to make specific recommendations for improving the full utilization of the commercial item designation provisions. This objective is critical to contracting and acquisition commands (as well as those they support) to achieve reduced acquisition lead times, reduce transactional costs, and generally, garner efficiencies and effectiveness not possible without the legislative provisions. The research would: 1) provide an overview of the legislation; 2) investigate current business practices within DoD related to the legislative provisions; 3) analyze and



determine the extent to which DoD is capitalizing on the provisions, and; 4) make specific recommendations for better utilizing the legislation to the benefit of DoD.

Methodology: A thorough review of literature and legislative and implementing guidance will be conducted. Interviews with key acquisition and contracting leaders, along with key supported customers will be conducted to determine command structures, protocols and ability to capitalize on the legislation. There is a high potential for other instructors and students to participate in this project. As of the date of this proposal, I am working to identify other participants, although other participant identification should not preclude acquisition of funding.

Research Outline

I. Introduction:

- Research questions
- Intent and Utilization of Findings
- Selection of Research Locations
- Introductory Conclusion

II. Background:

- Basic premises
- Legislative and Regulatory history
- Section 800 Panel
- FARA
- FASA
- Clinger-Cohen
- ASIA
- FAR 13.5
- Extension of FAR 13.5
- Commercial Item Definition
- Background conclusions

III. Implementation Program Guidance & Reporting:

- Legislation
- Specific Language (flow down)
- Advocates (tier flow down)
- Federal and Agency Regulations
- Specific Language (flow down)
- Advocates (tier flow down)
- Implementation Program Conclusions

IV. DD350 Data Review:

- Explanation of DD350 Reporting
- Isolating FAR 13.5 Transactions
- Actions \leq \$5 million but \geq \$100 K
- Actions \leq \$100 K but \geq \$ 2500
- Identify those under GWACs
- Identify other types of streamlined actions



NAVSUP Data Call (2003 and 2004)
FISC San Diego DD350 Data
FISC Jacksonville DD350 Data
DD350 Data Conclusions

V. FISC Contracting Office Design and Staffing:

Organization
Delineation (Micro, SAP, Large)
Training and Warranting (Micro, SAP, Large)
Workload Levels (Specific to FISC manning)

VI. Procedures and Protocol at Field Activities:

Published Protocol
Requisition Processing (SAP)
Requisition Processing (Large)
Determining Commercial Item Status and FAR 13.5 Eligibility
Compare and Contrast SAP v Large
Inputs
Decision Criteria for Assignment
SPS “built in” Protocol utilizing monetary breakdown indicated above
Examine Specific FAR 13.5 Eligible Transactions
Actions \leq \$5 million but \geq \$100 K
Actions \leq \$100 K but \geq \$ 2500
Identify those under GWACs
Identify other types of streamlined actions

VII. Conclusions and Recommendations:

Eligible Universe v Action Employment
Structure and Protocol
Manning
FAR 13.5 Implementation
Way Ahead

VIII. Bibliography and Footnotes



Improving Public Perceptions by Instilling Objectivity in Decisions to Waive Procurement Regulations

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Abstract

The general public often perceives the government to be bureaucratic. One reason is that the public perceives that the government too rigidly enforces laws and regulations or that favoritism or bias influences decisions to make exceptions or waivers of rules. Although observed in various contexts, such perception is particularly evident in government contracting and procurement. This perception can erode the public confidence in government; thus, improving the public's perception is paramount. An approach to this perception problem involves instilling objectivity in a government decision to make an exception or "waiver" of a procurement rule or regulation. Analytical techniques can be used to evaluate the decision of whether or not to waive a particular procurement rule or regulation. Granted, a waiver may be unnecessary in exigent circumstances (where life or health is in imminent danger) because procurements under such exigent circumstances are often exempt from application of procurement rules. Yet, absent such exigent circumstances, a waiver of a particular regulation may require a formal exception by an administrative body, an executive, a court-issued injunction, or even legislation.

Introduction

Prompt action is often necessary in response to an event or course of events. Yet, regulations often prevent immediate action in procurement—though some exemptions exist which allow such necessary action to rectify emergencies or exigent circumstances, e.g., imminent danger to life, health or public welfare. In this paper, "prompt" action is action of an urgent nature intended for a legitimate purpose but that falls short of the definition of an "emergency." Thus, by analog to medical services, the author distinguishes between "urgent" treatment and "emergency" treatment. Broadly speaking, regulations that are obstacles to prompt action include environmental impact regulations and procurement regulations. Although the techniques discussed in this paper could be applied to both categories of regulations, the discussion in this paper is limited to procurement regulations.

Objective analytical techniques (such as benefit-cost ratio or return on investment) are often applied to decision-making involving alternatives. These analytical techniques can be used to evaluate the decision of which alternative to pursue. For example, benefit-cost ratio can be used to evaluate whether or not one should waive a particular regulation relating to procurement such as advertisement or competitive bidding. Granted, a waiver may be unnecessary in exigent circumstances that comprise an "emergency" where life or health is in imminent danger; procurements under such exigent circumstances are often exempt from application of procurement rules. Yet, absent such exigent circumstances,



exemption from a particular regulation may require a formal waiver or exception by an administrative body, an executive, a court injunction, or even legislation. Objective analytical techniques can effectively demonstrate whether it is economically justifiable to pursue a waiver in a particular situation. Objective legal analysis can be used to determine whether a decision is supported by applicable law. Using examples of procurements from 2005, the paper examines scenarios where waivers of certain regulations may be justified by analytical techniques, and in particular, benefit cost analysis. One example is the procurement of cruise ships as temporary housing in the City of New Orleans. Another example is the procurement of repairs to levees. Other examples include procurements in support of military operations in Iraq. In each of these examples, a “waiver,” exception or the other means of avoiding application of procurement regulations is assumed necessary to respond to a problem of an urgent nature.

To instill objectivity and improve public perceptions of procurements, the author calls for application of decision analysis to various alternatives that may possibly be used to avoid procurement regulations. Although not exhaustive, a list of alternatives is shown in Table 1.

Table 1. Alternative Strategies by Government Branch

Alternative	Legislative	Executive	Judicial	Administrative
I. Establish on-call contractor to expedite response				X
II. Waiver of procurement rule		X		X
III. Declaration a state of emergency		X		
IV. Activate national guard or reserve forces		X		
V. Seek special legislation	X			
VI. See injunctive relief through the judicial system			X	

In the following sections, the author discusses each alternative and gives examples of the potential of each in the order of its likely application.

Establish On-call Contractor

It is prudent for a jurisdiction—e.g., federal, state, or local—to establish contracts with one or more contractors to be immediately available or “on-call” in an emergency. Generally, an on-call contractor would be selected based on a competitive selection

process. The process and contract form entered into with the contractor could vary depending on the jurisdiction. Thus, the jurisdiction would be prepared in the event of an “emergency” (according to the jurisdiction’s definition of the term). Yet, many jurisdictions have limited the use of an on-call contractor to only to “emergencies” and not to “urgent” problems.

A best practice is to also establish contracts with one or more contractors who would be available or “on-call” within a specified time to address needs other than emergencies. Such a practice is allowed by procurement regulations in many jurisdictions and is justified on several grounds—including efficiency and responsiveness. For example, an on-call contract may take the form of a job order contract whereby (i) the base contract defines the terms, general conditions, and profit and overhead, and (ii) the individual work orders define the scope of work at the time the need arises. Besides emergencies, a growing number of public agencies use on-call contracts to address general or routine needs of the public agency. For example, the federal government uses indefinite delivery, indefinite quantity (IDIQ) contracts, which is a form of “on-call” contract, to perform various types of work. However, a problem with “on-call” contracts that are intended for general or routine work is the “response time.” For example, the time which the contractor is required to respond may exceed the time required for “urgent” problems. Thus, such contracts for general or routine needs generally do not catalyze prompt response in urgent situations. Hence, “on-call” contracts may be frequently used to address emergencies and increasingly used to address general or routine needs, but are underused to address pressing problems that do not meet the definition of an emergency. A comparison of the frequency of use of “on-call” contracts is show in Table 2 below.

Table 2. Frequency of Use of “On-call” Contracts

Category of need	Use
Emergency	Very frequent
Urgent	Underused
Common or routine	Somewhat frequent

Waiver or Modification of Procurement Rules by Executive or Administrative Action

As stated above, having an “on-call” contract may obviate the need to waive a procurement rule. In the absence of an “on-call” contract, a public agency may consider the alternative of waiving a procurement rule to award a contract if permitted under the applicable law or regulation. For the purpose of this paper, the author assumes that waiver of a rule will not include waiving of competition but will still require some form of competitive selection. The understood intent of waiver of a procurement rule is to reduce time required to complete a procurement with little or no increased cost.

Assuming substantial benefits in waiving a given procurement rule, a small or negligible increase in cost results in a benefit-to-cost ratio much greater than unity. Similarly, the return on investment analysis would be positive. Thus, decision analysis can demonstrate support for waiver of the procurement rule. Waiver of specific procurement rules can have varied effects on the outcome of a procurement—including both time and cost. The common theme among waiving specific procurement rules is the potential savings of time. For example, waiving in-print publication in favor of electronic publication can save

time in the procurement schedule, and, at the same time, reduce cost by avoiding printing costs. Similarly, shortening the bid period can save time without substantially increasing cost, especially if combined with a cost plus fixed-fee (CPFF) contract. In another example, waiving a sealed bid in favor of a faxed or e-mailed bid can save time. In still another example, waiving a firm fixed-price in favor of a reimbursable contract having a fixed fee (such as CPFF) can save time in preparation of bids. In yet still another example, shortening the protest period and pre-approval of insurance can save time in the procurement schedule. Each of these examples is shown in Table 3 below.

Table 3. Modified Rule by Procurement Rule Category

Category	Modified Rule
Public advertisement	Notice by electronic publication only
	Shortened bid period
Sealed bids	Allowing faxed or e-mailed bids
Prebid meetings	Holding meeting by video conference
	Making optional vs. mandatory
Key contract terms	Establishing fixed fee vs. fixed price
Due diligence	Pre-approval of insurance
Bid Protest	Shortened protest period

In the event a need arises that requires urgent action, a public agency must determine at the Executive or a lower administrative level if the authority exists to waive or modify one or more procurement rules. If authority exists for such waiver or modification, the public agency may proceed with the procurement. If authority does not exist, the agency may have to conduct a regular procurement or may need to consider an alternative course of action. For example, following the events of levee failures due to hurricane Katrina, a dam failure in Hawaii and near record rainfall in California, the governor of state of California issued an executive order proclaiming a state of emergency of levees in California (Schwarzeneger, 2006). The order sought to obtain federal funds and waived advertising and competitive bidding rules to accomplish “expedited repairs.” Yet, the executive action had limitations because an executive order could not waive California’s Environmental Quality Act (CEQA); therefore, legislative action was required. The limitations of state-of-emergency declarations are discussed in the next section.

Declaration of State of Emergency

The intent of a chief executive’s declaration of a state of emergency for a jurisdiction has generally been to provide funds for disaster relief and recovery. By definition, the chief executive’s authority is often limited to response to an “emergency,” e.g., a disaster or crisis. Thus, an executive may not have authority to suspend procurement regulations depending on applicable federal or state law. An implied power of a chief executive is to execute contracts, e.g. purchase and sales contracts. Although an executive has these implied powers, such authority is subject to the laws duly enacted by the legislative body of the jurisdiction. For example, Congress (as the legislature of the United States) may restrain the power of the President as the chief executive. Thus, Congress may restrain the ability of

the President to conduct procurements, even under times of national emergencies (GPO, 2002). For example, when hurricane Katrina devastated the gulf states, the federal government could only respond initially within its existing authority despite the federal declaration of a state of emergency which authorized expenditure of federal funds. Congressional action was still required to obtain authority to waive procurement rules other than for “emergencies” as that term is defined by statute.

Activate National Guard or Other Forces

Under certain circumstances, a public agency may activate local units of the National Guard or other forces in response to an urgent problem. Although this is not an alternative for a local jurisdiction, the local agency may request such activation by the state or federal jurisdiction. One example is activation of National Guard units to maintain order after a natural disaster. Another example is activation of the Ready Reserve Force (RRF) for troop or equipment transport in a sea lift or air lift. Still another is activation of the Merchant Marines for transport or housing of civilians in times of war or national emergency, including natural disasters (US Congress, 1996). For example, following hurricane Katrina, the United States did not activate a US Merchant Marine ship, but instead negotiated a contract with a cruise line under a foreign flag to provide housing for displaced civilians in New Orleans.

Seek Special Legislation

Although special legislation may be sought to waive a procurement rule, this alternative would not normally apply for procurements to address urgent problems. The legislative body of a public agency will typically provide funding for a program and then allow the executive to carry out the program; thus, the legislative body does not consider every individual project (PMI, 2006). Since the legislative body does not consider every individual project, it would not normally consider waiving a procurement rule for an individual project. Further, the legislative body may not be currently in session, and thus, would be unable to promptly respond to a request for a waiver. Thus, legislative relief may be unavailable.

Seek Injunctive Relief

If the chief executive of a public agency has the authority to waive a procurement rule, the public agency would not likely have to seek injunctive relief. However, if the chief executive does not have such authority, the public agency may wish to consider seeking injunctive relief from the judicial system—provided there is a valid ground or grounds to seek such relief. If the public agency envisions seeking injunctive relief, the legal representative of the public agency should have prepared a motion for temporary restraining order (TRO) and supporting legal brief stating the ground(s) on which the motion is made. In this way, the injunctive relief sought is temporary suspension of the procurement rule.

Conclusion

Multiple alternatives may exist with respect to seeking an exemption to a procurement rule. These may include approaches involving the executive, administrative, legislative and judicial branches of government. Depending on the alternative, waiver of a procurement rule may be fully supported by decision analysis; therefore, the decision to waive a rule would be instilled with objectivity. In addition, waiver of a procurement rule



should be fully supported by applicable law and regulation as modified by court order. In any event, the procurement rule should not be ignored because this may lead to public perception of improper or illicit behavior. Instead, a formal waiver or exception should be obtained. Finally, notwithstanding waiver or modification of other procurement rules, a public agency should strive to maintain competition in procurements in order to preclude a public perception of favoritism, self-dealing, or other unethical behavior.

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The Use of Alternative Dispute Resolution Techniques in United States Air Force Environmental Conflicts

Presenter: SMSgt Nanci R. Pigeon, USAF, 609 Air Support Squadron/A4/LGC

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Abstract

The use of alternative dispute resolution (ADR) in government disputes is mandated by the Administrative Dispute Resolution Act of 1990. The use of ADR to resolve disputes typically provides a quick and inexpensive resolution when compared to litigation. The Air Force has a very strong ADR program to resolve acquisition and workplace disputes; however, the varied conditions and situations of environmental issues have prevented the Air Force from achieving similar success in this area. This research analyzes the experiences of twenty-six Environmental Conflict Resolution practitioners who have resolved environmental disputes using ADR techniques. Content analysis and pattern matching were used to provide insight into the current use of ADR techniques in military environmental disputes. The insight gained from this research provides the Air Force with information to better understand the current practices in environmental ADR and also provides areas for further research.

Introduction

Alternative Dispute Resolution (ADR) is an umbrella term that refers to means of settling disputes other than through court adjudication (Nolan-Haley, 1992:1), for example, though negotiation, mediation, and arbitration. Because ADR promises several significant benefits, the Federal government mandated the use of ADR in any case in which the government was a party through the Administrative Dispute Resolution Act (ADRA) of 1990 (amended in 1996). Consistent with ADRA, Air Force policy is to use Alternative Dispute Resolution (ADR) to the maximum extent practicable to resolve disputes at the earliest stage and at the lowest organizational level possible (AFPD 51-12, 2003:2). Within the Air Force, the Deputy General Counsel for Dispute Resolution (SAF/GCD) has overall responsibility for the Air Force Dispute Resolution Program, which has been recognized especially for its effectiveness at resolving acquisition and workforce disputes (Air Force ADR Program Office 2004).

Federal workplace disputes, such as equal opportunity complaints, are governed by a formal dispute resolution process (Equal Employment Opportunity Commission, 2003). Similarly, acquisition dispute resolution is governed by a formal process spelled out by the Federal Acquisition Regulation (FAR). Unfortunately, circumstances surrounding environmental issues typically are not so clear cut as those in workplace and acquisition disputes. Environmental disputes can involve issues such as land use, water resources, natural resource management and air quality. The parties involved in environmental disputes can range from one party to hundreds of parties and fall into several categories, for



example, federal government, state government, local government, citizen groups, environmental groups, and various other private interest groups. Because of the complexity of environmental disputes, the Air Force has made much less progress applying ADR to environmental disputes than it has to workplace and acquisition disputes (Southern, 2004:1).

Another barrier to successful ADR implementation in environmental issues is that the Air Force is not always able to retain oversight of the process. For example, the Air Force faces challenges of environmental cleanup and remediation, which are covered by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and typically are turned over to the district courts. From that point, the process is controlled by the Department of Justice (DOJ). The district court must approve the consent decree executed by the parties and the DOJ must approve the final results on behalf of the United States. The ADR process can be used to negotiate the consent decree but it requires up front coordination with the DOJ (O'Sullivan, 2004:1). The ability to apply the ADR process in a timely manner—before the dispute is referred to DOJ under CERCLA—is the biggest problem the Air Force faces in the environmental arena (Southern, 2004:1).

The Research Problem

The Air Force has enjoyed significant success employing ADR to resolve workplace and acquisition disputes. Now, it wants to extend its very successful use of ADR into the environmental arena. Thus, the primary purpose of this research is to assess usage of ADR in the environmental arena and offer recommendations to the United States Air Force ADR Program Office on how to participate more effectively in the process. In making this assessment, the study analyzes ADR techniques and processes, and both the antecedents of, and barriers to, successful ADR usage. The data analyzed comes from environmental conflict resolution practitioners who have a wide range of experience in all facets of environmental dispute resolution. By investigating the use of ADR techniques in environmental disputes generally, and within the Department of Defense specifically, this study seeks to better understand how the Air Force can apply more effectively its successful ADR capability to environmental disputes.

Literature Review

Dispute resolution is the act of settling disagreements between parties through means other than litigation (Nolan-Haley, 1992:1). Dispute resolution can trace its origins to 1768, when arbitration was used to settle business disputes among tradesmen (Singer, 1994:5). Current dispute resolution practices have grown out of the 1976 Roscoe Pond conference convened by Warren E. Burger, then Chief Justice of the Supreme Court (Singer, 1994:7; Nolan-Haley, 1992:5). Burger was concerned that "...we may well be on our way to a society overrun by hordes of lawyers, hungry as locusts, and brigades of judges in numbers never before contemplated," and that "...we have reached the point where our systems of justice—both state and federal—may literally break down before the end of this century" (Burger, 1982:274).

Expanding on Nolan-Haley's (1992) definition, the term alternative dispute resolution or ADR has been assigned to the field of practice where parties in a dispute use various means other than resorting to violence, strikes, litigation, or doing nothing to resolve conflict (Singer, 1994:15). ADR is popular because it saves time and money compared to the normal legal process (O'Leary and Husar, 2002:1269). Today, ADR is used in every area



imaginable. Businesses are including provisions in their contracts with customers to resolve disputes by mediation and/or arbitration; workplace disputes solved through ADR encompass equal employment issues, personal conflicts, or labor disputes; family courts are referring more and more cases of family disputes (divorce/child support) to mediation; some local courts require mediation prior to trial in small claims disputes; community boards have been created to help mediate landlord-tenant disputes, neighborhood conflicts, and family rifts; even some high schools have trained students to mediate disputes between other students, between teachers and students, and even between parents and students (Singer, 1994:8-10).

An additional catalyst of current ADR usage was the passage of the 1990 Administrative Dispute Resolution Act (ADRA), which was amended in 1996. This Act required all federal agencies to develop policies on the use of ADR, appoint an ADR specialist, and provide appropriate employees with training in ADR (5 USC § 571, 1990). Along with ADRA came an executive order mandating federal agencies that litigate use ADR techniques in appropriate cases (Singer, 1994:10). Also in 1990, the Civil Justice Reform Act (CJRA) was passed requiring all federal district courts to create advisory committees to consider ways of reducing cost and delay of civil litigation (28 USC § 471, 1990). The CJRA directed each committee to use ADR to reduce cost and delay (Singer, 1994:10).

The true spirit of ADR is face-to-face meetings of all stakeholders in a dispute to reach a consensus on a solution (O'Leary, Durant, Fiorino, and Weiland, 1999:3). O'Leary et al. (1999) suggested five principle elements that characterize ADR methods (except binding arbitration): (1) the parties agree to participate in the process; (2) the parties or their representatives directly participate; (3) a third-party neutral helps the parties reach agreement but has no authority to impose a solution; (4) the parties must be able to agree on the outcome; and (5) any participant may withdraw and seek a resolution elsewhere.

Scholars also have attempted to understand characteristics of successful ADR. Hopper (1996) proposed five antecedents for the successful use of ADR: 1) long-term relationships, 2) existence of a formal ADR process, 3) top management support, 4) acceptance of ADR by all parties as a valid process, and 5) greater economic ramifications (see Figure 1).

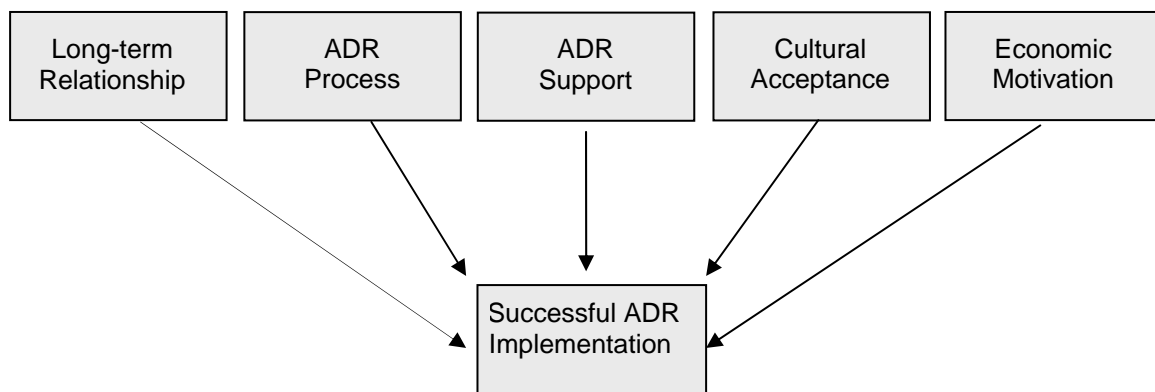


Figure 1. Hopper's Antecedent Model

ADR Techniques

Traditional litigation can be a confrontational situation resulting in winner-take-all scenarios; ADR, on the other hand, tries to downplay confrontation and develop a win-win environment where both parties feel like they have won some concessions (O'Leary and Husar, 2002:1269). Generally, the ADR process is voluntary and is initiated by the parties involved to obtain a mutually acceptable resolution (Bingham, 1986:5). In fact, the most successful ADR outcomes are between parties that have ongoing relationships (Nolan-Haley, 1992:3). In most instances, the use of ADR to resolve an issue saves time and money over litigation and also tends to produce a better outcome that all parties can live with (Nolan-Haley, 1992:4; Singer, 1994:13).

Singer (1994:16) provides one classification of ADR techniques and how each one fits into the ADR process (see figure 2). The further the parties move to the right on the spectrum, the less control the parties will have and the higher the cost will be (Singer, 1994:15).

Unassisted Negotiation	Assisted Negotiation		Adjudication
	Mediation	Outcome Prediction	
	Conciliation	Neutral Evaluation Fact-Finding	Arbitration
	Facilitation	Ombuds and Complaint Programs Mini-trial	Agency
	Regulatory-Negotiation	Summary Jury Trial Nonbinding-Arbitration Mediation-Arbitration	Court

Figure 2. The ADR Spectrum

Unassisted negotiation, in which the parties seek to resolve differences without outside help, is the basic form of dispute resolution and is foundational to all other forms of dispute resolution (Nolan-Haley, 1992:11). With this exception the ADR process involves third-party neutrals to help the parties involved in a dispute come to a resolution (Nolan-Haley, 1992:11).

Assisted negotiation is divided into two general categories of techniques: mediation and outcome prediction. In mediation the parties are assisted by a third party neutral to come to an agreement. The mediator facilitates the parties' interaction (O'Leary, 2003:11), but lacks decision-making authority (Equal Employment Opportunity Commission, 2002). Mediation approaches can be distinguished by whether the mediator becomes involved in the substance of the dispute (mediation) or focuses primarily on facilitating interaction (facilitation) and/or building relationships (conciliation) (Equal Employment Opportunity Commission, 2002; O'Leary, 2003:11-12; Singer, 1994:24). The special case of regulatory negotiation involves mediating proposed regulatory verbiage before it is published (O'Leary, 2003:12).

Outcome prediction occurs when the parties have a third party predict the most likely outcome if the case were to be adjudicated. In most cases this prediction motivates the parties to reach a settlement. Various approaches to outcome prediction have been identified. Neutral evaluation and fact-finding emphasize documenting the facts and issues, and perhaps issuing a non-binding opinion as to how the dispute should be resolved (O'Leary, 2003:14-15; Singer, 1994:25). Ombuds programs extend fact-finding by attempting to mediate the dispute once the facts are determined (Nolan-Haley, 1992:204). Mini-trials and summary jury trials are both quasi-judicial processes that mirror what may happen if the cases were to go to trial. The parties present cases either to executives from their organizations or to a mock-jury, who make recommendations for resolving the dispute. The parties are not bound by these recommendations, which are intended to facilitate resolution through further negotiation (O'Leary, 2003:14).

Finally, adjudication occurs when the parties cannot come to an agreement and a third party determines the outcome. Arbitration is a more formalized ADR technique. In the arbitration process the parties present their case to a neutral third party who then renders a decision. Arbitration can be either binding or non-binding. If it is binding then the decision of the arbitrator is final. If it is non-binding then the parties have the option to seek other remedies (Nolan-Haley, 1992:124; Singer, 1994:15). Binding arbitration is not used in federal cases; this is because the decision would delegate legislative power to the arbitrator who is not accountable to the public for the decision (Nolan-Haley, 1992:126). A hybrid form of dispute resolution, mediation-arbitration, is used when the parties want a binding decision if they cannot reach an agreement (Singer, 1994:27). The mediator works with the parties to reach an agreement but if no agreement can be reached then the mediator typically becomes the arbitrator and decides the outcome (Singer, 1994:27, Nolan-Haley, 1992:201).

Environmental Conflict Resolution

Environmental conflict resolution (ECR) is the use of ADR techniques to resolve environmental disputes (O'Leary, 2003:5-6). The first documented use of ECR in the U.S. was in 1973, when the governor of Washington invited mediators to help settle a long-standing dispute over a flood control dam on the Snoqualmie River (Bingham, 1986:1). Since that time, ECR has evolved along-side other ADR processes like workplace and acquisition dispute resolution.

ECR has reached its current popularity largely due to the Environmental Protection Agency (EPA), which in 1981 became one of the first federal agencies to implement ADR (Bourdeaux, O'Leary, Thornburgh, 2001:176). In 1987, the EPA issued guidelines and established a review of all enforcement actions for resolution by ADR (Bourdeaux et al., 2001:176). Today, the EPA is a leader among other federal agencies in the application of ADR to a wide range of disputes (Bourdeaux et al., 2001:176).

The EPA (2000) listed its most-used ADR techniques as facilitation, convening, mediation, consensus-building, and ombudsmen. Convening (or conflict assessment) uses a third party to determine the cause of the dispute and identify the parties that would be affected and help those parties determine the best way to resolve the issue. Consensus-building is when people agree to work together, informally, to resolve a problem (EPA, 2000:2). O'Leary and Husan (2002) found that mediation was by far the most frequently used technique among environmental attorneys, with 82.6% of respondents in the study reporting having used mediation; negotiation followed with 67.9% and facilitation rounded



out the top three with 25.7% of respondents reporting experience using the technique in environmental disputes.

Bingham (1986) first classified typical ECR cases into six broad categories: land use, natural resource management and use of public lands, water resources, energy, air quality, and toxics. O'Leary and Husar (2002:1271) offer a different list that provides a more detailed list of possible dispute cases. They found that ECR had been used most frequently in hazardous waste cleanup (53.2%), which is perhaps not surprising since the Superfund law allocates funds specifically for ADR use. Use of ECR varied among the remaining categories: quality (36.7%), solid waste (22%), land use (18.3%), water quantity (14.7%), air pollution (13.8%), siting disputes (11.9%), oil and gas exploration (10.1%), endangered species (10.1%), and pesticides (3.7%). (Responses sum to greater than 100% because respondents in this study were allowed to choose all types of ECR in which they had participated.)

Given the broad list of potentially contentious areas, it is perhaps not surprising that environmental disputes frequently have multiple stakeholders, including federal, state, and local governments; citizen groups; environmental groups; private interest groups; any potentially responsible parties; and the facilitator/mediator. This broad range, and sheer number, of interested parties increases the complexity of ECR. (Andrew 2000).

Methodology

The primary purpose of this research was to assess usage of ADR in the environmental arena and offer recommendations to the United States Air Force ADR Program Office on how to participate more effectively in the process. This study analyzes ADR techniques and processes, and both the antecedents of and barriers to, successful ADR usage. The data analyzed comes from environmental conflict resolution practitioners who have a wide range of experience in all facets of environmental dispute resolution.

Qualitative Research

Research on environmental ADR exists. However, this specific research focuses on the use of ADR in military environmental disputes, an area underrepresented in the literature. Accordingly, a qualitative research approach was chosen to collect open-ended data with the goal of determining themes in the data (Creswell, 1994:7). The data gathered from this research will be used to build theory on this topic, and the results will be synthesized into conclusions and recommendations for improving the use of ADR in military environmental disputes.

Participant Selection

The participants for the study came primarily from two sources. The first source was the National Roster of Environmental Dispute Resolution and Consensus Building Professionals ("Roster of ECR Practitioners"), which is managed by an independent, impartial federal program established by Congress to assist parties in resolving environmental, natural resource and public lands disputes. The roster was developed with the support of the EPA (Institute for Environmental Conflict Resolution, 2004). A search of the roster was conducted using military/base experience as the searchable term. This search yielded sixty-nine practitioners. Each of the sixty-nine practitioners were contacted and asked if they would consent to be interviewed. One of the practitioners supplied two



other names, bringing the total of practitioners contacted to seventy-one. Of the seventy-one, forty-one either declined or did not respond to the request; thirty initially agreed to be interviewed. Of these thirty, twenty-six practitioners (36.6 percent) were actually interviewed; the other four either did not answer the second invitation to be interviewed or were too busy to be interviewed during the interview time period.

The practitioners interviewed represent a wide-selection of the practitioner populace, which provides some confidence to suggest the results may generalize. A demographic profile of the respondents was developed from data from the IECR database. Eighteen (69%) of the 26 respondents were male. All respondents had Bachelor degrees; 19 had a Master's degree; seven held the Jurist Doctorate (JD) and five held the Doctorate of Philosophy (PhD). Position titles varied: eleven (42%) respondents were president or owner of their company, and the rest held positions such as director, mediator/senior mediator, or partner/senior partner. Eight (31%) of the respondents worked for firms specializing in ADR, seven (27%) worked for a nonprofit organization, five (19%) worked for an environmental consulting firm; and two (8%) worked for a governmental agency; the remainder worked in law firms, consulting firms and similar organizations. The respondents offered services in consensus-building (100%), mediation (96%), conflict assessment (96%), facilitation (92%), regulatory negotiation (81%), dispute system design (62%) and neutral evaluation and fact-finding (50%); a smaller percentage (35%) worked on Superfund Allocation issues. Respondents were located across the country, with a few areas of geographic concentration including Colorado (six respondents), California (four), and Virginia/DC (five). Fifty percent or more of the respondents reported having worked on disputes in essentially all regions of the United States (north central states were slightly lower at 42%). Respondents also reported experience working in 38 foreign countries spread across all six major continents. Two-thirds of respondents reported working at least twenty-five cases in the previous ten years, and 23 percent had worked at least fifty cases. The typical respondent spent less than one-hundred hours (62%) on a case; twenty-three percent reported spending between one and two hundred hours, while a few respondents reported spending more time and two respondents did not report an average number of hours.

During the course of the interviews several practitioners mentioned that they had worked with Restoration Advisory Boards through the Installation Restoration Program. The Installation Restoration Program (IRP) was established by the Department of Defense in 1975 to provide guidance and funding for the investigation and remediation of hazardous waste sites caused by historical disposal activities at military installations. (DERP, 2004). The Restoration Advisory Board (RAB) provides a forum for communication between community members, the military organization, and regulatory agencies.

The main purpose of the RAB is to represent the interests of the general public and serve as a community point of contact. The boards are made up of local community members, environmental regulators, local government officials, military representatives and other interested parties. The RAB encourages community participation in the cleanup process and provides community members and other stakeholders the opportunity to have meaningful dialogue with and provide advice and recommendations to the military officials (DERP, 2004). Many bases use these programs to determine what environmental issues need to be addressed and then initiate discussions in an open forum with participants from the local community. The public is kept informed of what environmental issues the bases have and can comment on the procedures the base is using to clean up the contamination.



It is a consensus building, public participation tool that has been put in place by the Department of Defense.

Base Realignment and Closure (BRAC) bases have similar programs set up to gain community involvement in reaching agreements on clean-up and other base closure issues. The terms used for the teams in the BRAC cases are BRAC Cleanup Teams (BCT) and Local Redevelopment Authorities (LRA). One recent success story of an Air Force BRAC base is Kelly AFB in San Antonio, Texas. Kelly was recognized by the National Association of Environmental Professionals with the National Environmental Excellence Award for Public Participation. "Kelly Air Force Base reached award-winning levels of involvement through exceptional public outreach, collaboration with local organizations, and strong partnership with the community (DERP, 2004:3)." Kelly's outstanding efforts with the community has put it on target for achieving its last remedy one year in advance of the BRAC deadline, and 11 years ahead of the Air Force goal (DERP, 2004:1)

Data Collection and Analysis

The data was collected primarily using a semi-structured interview format. Seven investigative questions were developed to address the primary research problem of understanding current environmental ADR usage and identifying antecedents of and barriers to successful AF application of ADR to environmental cases. Each investigative question was decomposed into several interview questions. Twenty-two interviews were conducted over the phone, and because of practitioner preference, four were conducted by email. The interviews were taped and transcribed, and the transcribed interview was sent to each interviewee for review and concurrence.

For the Defense Environmental Restoration Program contacts, ten Air Force Base environmental points of contact were sent a questionnaire via e-mail. The ten installations were chosen because the Defense Environmental Restoration Program website described them as having outstanding environmental programs. The questionnaire was similar to the one the practitioners answered, but questions were adapted where needed to target installations rather than individuals (i.e., practitioners). E-mail was chosen as the primary means of contact because the research team only learned of this program late in the study, and email provided a way to reach many potential respondents quickly. Two installations answered the questionnaire, three others indicated they did not have enough experience to answer and five others either did not respond or the point of contacts e-mail was no longer active.

The data collected from both sources was scrutinized, coded, and analyzed using categorization and frequency counts for patterns, themes, and biases (Creswell 1994; Leedy and Ormrod 2001). Additional data was obtained from the literature on environmental issues; this additional data was compared to the primary data, a method known as triangulation, which enhances validity by increasing the probability that the researchers conclusions are the most probable based on the data (Leedy and Ormrod, 2001).



Case Study Analysis, Results, and Discussion

This portion of the paper presents a summary of the analysis and results, and then draws conclusions based on those results. For each interview question, data was collected and analyzed as described in the methodology.

Investigative Question 1: Typical environmental disputes

The first area of interest in the study was to understand “typical” environmental disputes. To that end, the first investigative question asked, “What are typical environmental disputes?” Three interview questions were asked in order to answer this question.

- *Question 1a: What types of environmental issues (i.e. water quality, solid waste, land use, etc.) have you consulted on in the past 5 years?*

The practitioners reported having consulted on twenty-nine different types of environmental issues. The top six issues, *Land Use*, *Superfund*, *Water Quality*, *Solid Waste*, *Water Quantity*, and *Clean Air*, correspond to O’Leary’s (2000) top six issues, with *Land Use* appearing first on the respondents’ list and fourth on O’Leary’s (2000) list. The most commonly reported issues on which the practitioners had worked were *Land Use* (60%), *Superfund* (56%) and *Water Quality* (56%). Three other issues were reported by roughly one third of the respondents, and the rest were reported relatively infrequently. The two base IRB respondents mentioned similar issues generally, but had experienced mostly water-related issues themselves.

- *Question 1b: How many of those were military related? What type of issue did the military dispute(s) involve?*

Of the twenty-six practitioners interviewed, eighteen had actual military case experience. The three without military case experience had erroneously been classified as having military/base experience in the IECR Roster of Practitioners. The majority of the practitioners with military/base experience have consulted on *one to four* military cases. Of the eighteen practitioners with military case involvement 44% had worked on *Superfund* issues, 17% on *Ground Water* issues, and 11% each on *BRAC* or *Land Use* issues. By definition the base IRB respondents were involved in only military-related cases.

- *Question 1c: How many environmental disputes do you consult on per year? In your opinion is that a lot?*

The majority of practitioners consult on one to ten cases per year. This was a harder question for most practitioners to answer because some of their cases last for longer than a year. Most practitioners felt that the quantity of environmental cases and the time involved in handling the environmental cases keeps them fully employed at all times. The IRB respondents had far more experience (“dozens of cases”) than the typical respondent, but noted that the number of cases had tapered off over time and that any issues occurring today are typically resolved at the installation or next higher level.



Investigative Question 1—Conclusions.

The analysis revealed no one typical dispute, but rather several disputes—*Superfund*, *Land Use*, and *Water Quality*—appear to remain high on the list of disputes over time. *Superfund* disputes appeared at the top of the list on both IQ 1a and 1b. Finding *Superfund* at the top of both lists is not surprising because *Superfund* issues are funded by the government for cleanup. Several respondents noted that available funding is a critical factor contributing to a greater likelihood the issue would be resolved.

Investigative Question 2: Typical parties to environmental disputes

The second investigative question asked “Who are the parties in a typical environmental dispute?” This question was answered by the following four questions. The first two questions were asked of both practitioners and installation representatives, while the last two questions were appropriate only for the practitioners.

- *Question 2a: What parties (i.e. local, state, federal agencies, environmental organizations, etc.) were involved (directly or indirectly) in the cases you consulted on? What was their involvement?*

The practitioners listed a wide range of parties involved with the top five being *Federal Government* (92%), *State Government* (88%), *Local Government* (73%), *Environmental Groups* (65%), and *Citizen Groups* (27%). This list is very similar to the list of typical parties from Andrew (2000), with the practitioners omitting only facilitator/mediator and potentially responsible parties from Andrew’s list. It appears that some form of government entity is typically involved as a party to the dispute and this can be attributed to the regulatory nature of environmental issues. Environmental groups, citizen groups, and other private parties are less involved as parties and their involvement tends to be based on the impact that the issue has on their lives or livelihood. The answers from the installations are very similar. Federal and state regulatory agencies are typically involved, with other organizations such as citizen or environmental groups added in depending on the issue at hand.

- *Question 2b: In your experience, who normally initiates the ADR process (which party)?*

The majority of the cases these practitioners have consulted on were initiated by a *Regulatory Agency* (46%), *another Government Entity* (38%), or *One of the Parties to the Dispute* (27%). The initiator is rarely an external party to the dispute, although several practitioners noted that external stakeholders can “propel” the government to initiate the ADR process. Respondents also emphasized that funding was important to get the process started and that since governmental organizations frequently had funding, it was perhaps less surprising they initiated ADR in a large number of cases. While the practitioners listed regulatory agencies as the primary initiator (46%) with other government agencies second (38%), the two installation representatives were familiar only with cases initiated by the Air Force.

- *Question 2c: Do you know who initiated the process in the military case(s)?*

The primary initiator in the military cases was *the EPA* in 35% of the cases reported. The *DoD* and *state regulatory agencies* followed with 23% and 19% respectively. Federal and state regulatory agencies initiate ADR in over half (54%) of all military cases. The



results also suggest that the initiators in military cases are primary parties; external parties initiate relatively fewer of these cases.

- *Question 2d: What EPA Regions have you dealt with during your consultations? Where there any differences in dealing with each Region (differing processes)?*

Practitioners reported the most experience in Regions 9, 8, and 1. Region 9 includes the states of Arizona, California, Hawaii, Nevada, American Samoa and Guam. Region 8 covers the states of Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming. Region 1 covers the New England states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. Most practitioners *did not feel they had enough experience to comment on differences*. Those practitioners who had worked in many regions believe *there are differences* among the regions in terms of personalities, amenability to ADR use, and procedural issues, but that they were “par for the course”.

- *Question 2e: Have you used/hired a third party neutral to help with the ADR process? Why?*

This question was asked only of the installations and was asked to determine if hiring a third party neutral is a common practice in Air Force environmental disputes. One installation reported using third party neutrals at the lowest level of resolution and noted that they had reaped significant returns from their use in terms of faster decisions and implementation, as well as greater respect and credibility among the parties. The other installation used them when issues could not be resolved at the lowest level among the parties themselves.

Investigative Question 2—Conclusions.

The analysis revealed that the parties to an environmental dispute are wide ranging and varied. Since the parties to an environmental dispute can consist of two parties to hundreds of thousands of parties it is harder to pinpoint what or who a typical party would be, beyond general groupings such as “government”, and “primary parties to the dispute”. These two categories tend to be consistent parties to disputes and of the two, government entities tend to be the main initiators of the process. The main reason for this appears to be that these agencies/entities tend to have the funds to spawn the process.

Investigative Question 3: Perceived uniqueness of environmental disputes

The third investigative question asked “How are environmental disputes different from workplace and acquisition disputes?” This question was answered by the following three questions. Because these questions compared various kinds of disputes and base IRB respondents focused only on environmental disputes, these questions were asked only of the practitioners.

- *Question 3a: Have you consulted on any workplace or acquisition disputes?*

The main objective of this question was to establish experience in workplace/acquisition in order to ask the next set of questions which will indicate the differences between environmental disputes and workplace/acquisition. The practitioners answered either “yes” or “no” to this question and if they answered “yes” they stated either workplace or acquisition. Seventeen practitioners had experience in either workplace or acquisition disputes; three practitioners had experience in both.



- *Question 3b: Did the ADR process used in the workplace/acquisition disputes differ from the environmental disputes? How did it differ?*

All seventeen practitioners who had experience in workplace or acquisition disputes indicated there were differences between workplace and environmental disputes. Only three practitioners had acquisition experience, however, so for this study, comparisons were only made between workplace and environmental disputes. The primary differences are reported in the conclusions below.

- *Question 3c: In your opinion which type of dispute (environmental, workplace, or acquisition) is best suited for the ADR process? Why?*

The majority response (8 respondents out of 17 with experience, or 47%) for this question was absolutely *all three are suited* for resolution by ADR. Several practitioners noted that “conflict is conflict”, and that while there is “no one ADR process”, applying ADR came down to matching “different tools” to “the context, the issues, the parties, and their goals”. On the other hand, four practitioners (24%) thought *Environmental* issues seemed most suited to ADR because they are typically large, complex, multi-party conflicts and also because of the public nature of the disputes. Only two respondents believed workforce disputes were best suited to the use ADR.

Investigative Question 3—Conclusions.

The main differences between workplace disputes and environmental disputes are that environmental disputes are almost always multi-party disputes and workplace disputes are typically two-party disputes. The second difference is the fact that environmental disputes tend to be very technically complex whereas workplace disputes typically are not. The largest group of practitioners believed ADR was equally suitable to all disputes, whereas a smaller but non-trivial group believed environmental disputes were best suited to ADR. Taken in sum, however, the large majority (12, or 71%) of ADR practitioners agreed that environmental disputes were very amenable to ADR.

Investigative Question 4: Techniques used to resolve environmental disputes

The fourth investigative question asked “Which ADR techniques are used to resolve environmental disputes? This question was addressed with two interview questions.

- *Question 4a: What ADR techniques have you used to resolve environmental disputes (i.e. mediation, arbitration)? Why?*

Consistent with O’Leary (2000), the majority of practitioners in this study use *mediation* or *facilitation* to help resolve environmental disputes. The respondents placed a real emphasis on consensus and collaborative work; most of the methods in which external parties get decision-making authority ranked toward the bottom of the list. The two base IRB representatives reported a total of one lawsuit between them. This is significant because the base reporting the lawsuit is a very large installation that has had numerous environmental issues over the course of its existence. That only one lawsuit has been pursued and won against the government might suggest its dispute resolution processes are working very well.



- *Question 4b: What ADR technique was used in the military case(s) you consulted on?*

The answers to this question mirror those in 4a. *Mediation* and *Facilitation* tend to be the most used techniques in military environmental disputes. Many of the respondents noted a large number of parties were involved. In a similar question, the base IRB respondents emphasized consensus building and informal mediation.

Investigative Question 4—Conclusions.

If an environmental dispute is resolved by ADR it is typically resolved using some form of mediation or facilitation or a combination thereof. Consensus building is also used extensively to help the parties get to the point where they can participate and resolve issues.

Investigative Question 5: Environmental disputes best suited to ADR

The fifth investigative question asked “What types of environmental disputes are most suited for resolution by ADR? This question was answered by the following two questions, which were appropriately addressed only to the practitioners.

- *Question 5a: In your experience, what type of environmental dispute (i.e. water quality, solid waste, land use, etc.) do you find most suited for resolution by ADR? Why?*

Most of the respondents believed ADR is suitable for all environmental disputes, and that the parties themselves, their relationships with each other, their positions and issues related to the subject matter, and their willingness to work toward success, were more important than the subject matter of the dispute itself. The base IRB respondents had experience only with their particular installations’ issues; while they believed the issues with which they were familiar were amenable to resolution, they were open to the idea that most issues were probably amenable to ADR.

- *Question 5b: In your opinion, are there environmental disputes that are not suited for ADR? Why?*

The largest group of practitioners felt all disputes are suited to ADR; however, a measurable minority believed certain types of environmental disputes are not suited for resolution by ADR. These disputes include *the need to establish a precedent, when parties are unwilling or unable to participate, when there are challenges to regulatory issues/interpretations, or when it involves a criminal act*. As one practitioner noted, ADR was not suitable “Only [in] the usual circumstances in which ADR is generally inappropriate—a novel issue of law; the need to establish a binding precedent; parties who are unwilling or unable to negotiate for psychological reasons; lack of time, money or other resources needed to negotiate effectively or to retain a neutral.” The base IRB respondents agreed that disputes were amenable to settlement unless the parties themselves were unwilling to settle.

Investigative Question 5—Conclusions.

The overwhelming answer to this question is that almost all environmental disputes are suited for resolution by ADR; the primary exceptions being those involving clear legal issues of precedence or legality. Given these exceptions, no one type of dispute is more



suited than another to resolution. The main contributing factor to successfully resolving a dispute is the willingness of the parties to resolve the dispute.

Investigative Question 6: Antecedents of successful environmental ADR

The sixth investigative question asked “What are the antecedents of a successful environmental ADR program?” This question was answered through the following five questions.

- *Question 6a: What factors in an organizational environment facilitate the use of ADR in environmental conflicts?*

The majority of the practitioners and both installation respondents answered that *top management support* is definitely a major factor in an organizational environment to foster ADR use. This answer also matches Hopper’s model as described in Chapter II. The next three answers *knowledge of ADR process*, *resources*, and *training of personnel* were also thought to be very important factors. Installation respondents also suggested a “desire to do the right thing”, funding, and conceptual “buy in” at all levels were important factors.

- *Question 6b: Do the parties involved in an environmental dispute typically have a formalized ADR process in place? Do you think it was helpful? Why or why not?*

Answers to this question varied somewhat among respondents. The majority of practitioners (57%) answered *no* to this question although another 23% indicated that *some agencies* do have a formalized process in place. Both installation respondents indicated that there are formalized processes within the organizations that they have dealt with. Finally, several practitioners expressed an opinion that ADR functions better when the parties create the resolution process themselves.

Hopper’s (1996) model of ADR antecedents indicated that parties who have a formalized process in place are more likely to have successful ADR implementation. It is possible that the practitioners in this study had a different understanding of an “existing ADR structure” than did those in Hopper’s (1996) study. For example, an existing structure could include detailed implementation instructions, but it could also include a more modest idea that policies exist encouraging ADR use. Such differences could account for the different responses and indicate a need for future research.

- *Question 6c: Do the parties involved in environmental disputes typically have a long-term recurring or single transaction relationship? Do you think these relationships have an impact on the outcome?*

The majority of practitioners (69%) indicated that most of their cases are between parties with *long-term recurring* relationships, noting that this long-term relationship engenders commitment to the ADR process.

- *Question 6d: What influence do economic ramifications typically have on the outcome of the resolution?*

Practitioners and installation respondents agreed that economic ramifications tend to have a *huge/big/immense* influence on the outcome of the disputes. This is also a key element in the Hopper (1996) model.



- Question 6e: What influence does legal ramifications (i.e. need to set precedent) typically have on the outcome?

One of the practitioners commented early on that environmental disputes are “bargaining within the shadow of the law”, therefore, it is really no surprise that the majority of practitioners indicated that legal ramifications have some form of impact on the cases. Installation respondents went farther, calling the legal ramifications a determining factor. Simply, the need for a precedent can end all interest in ADR. Additionally, in crafting a settlement, the parties are typically unwilling to go beyond what they believe a court would require them to do.

Investigative Question 6—Conclusions.

The analysis showed that there are key elements in environmental ADR that tend to lead to a successful outcome. These key elements are presented in Figure 3. These key elements are similar to those found in Hopper’s (1996) antecedent model. The model has changed to show the antecedents in an inverted pyramid with *Economic/Legal Ramifications* at the bottom. *Economic/Legal Ramifications* seem to be the catalyst as to whether or not the ADR process is even initiated; if the parties don’t feel they will get a better outcome (legally or economically) through an ADR process then they are less likely to come to the table. The next level shows *Long-Term Relationships* and *Organizational Culture*. These two elements appear to be the second key elements in progressing towards using an ADR process. If the parties are in a long-term relationship or want to maintain a long-term relationship then they are more likely to work together in an ADR process. If the culture of the organization promotes and uses ADR to resolve issues (including workplace or acquisition type disputes) then it is more likely to use ADR for other issues. The final level of key elements is, *Management Support/Employee Empowerment*, *Knowledge of ADR Process*, and *Time and Resources*. Once the ADR process has begun these three elements appear to be the key to a successful outcome. Management should maintain interest in the process as it proceeds and should empower the personnel they have sent to handle the process to make decisions for the organization. The personnel the organization sends to handle the process should have knowledge of how the ADR process works; this may mean additional training for specific personnel who then become the main ADR process agents for the organization. This process agent should also be assured that they will have adequate time and resources to work the process to resolution.

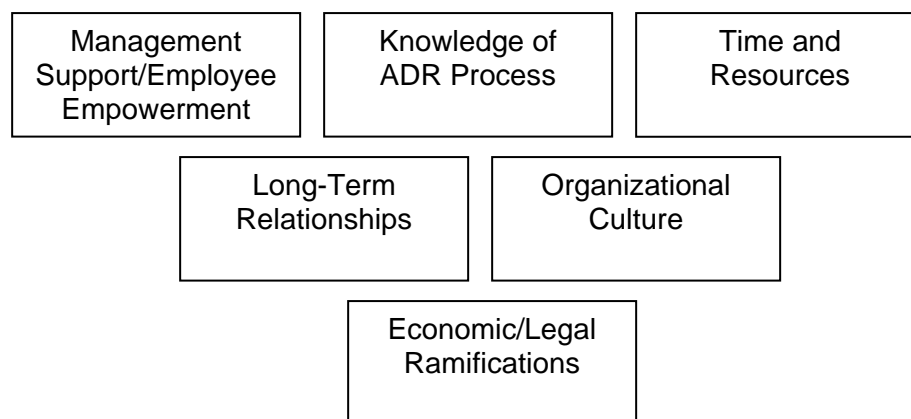


Figure 3. Key Environmental ADR Elements

Investigative Question 7: Barriers to implementation in the Air Force

The seventh investigative question asked “What barriers exist to implementing the process for the Air Force?” This question was addressed with five interview questions.

- *Question 7a: What is your experience with ADR in environmental disputes (i.e. positive, negative, or mixed) involving the military?*

The majority of the answers from both the practitioners (54%) and both installation respondents were *positive* regarding the practitioners experience with military cases. Only a few practitioner responses were *mixed* or *negative*. The negative responses voiced concern that the military did not “buy in” to the process and commit actual decision makers to it.

- *Question 7b: What are some key indicators that an environmental issue exists? When do most parties become aware of them?*

There were varying degrees of amusement in the answers to this question mostly due to the fact that the practitioners felt that it should be readily obvious to those who manage land or installations that there is a problem. Typical answers were: *That should be obvious* and *Too late*. The answer with the most responses was that a key indicator is typically an *environmental/regulatory trigger*. In other words, most parties don’t become aware of the environmental issue until something happens to bring it to their attention; they are not necessarily “looking for trouble”, but respond when it comes to their attention, perhaps through regular meetings either within the government or with the public.

- *Question 7c: How much control do you feel you have during the ADR process (initiation, negotiation, settlement)? Do you feel this level of control is adequate? Why or why not?*

Most of the practitioners answered this question in the same manner. They feel they control the processes to bring the parties together but the parties control the outcomes. As one practitioner noted, “Mediators need to have all the control the parties want to entrust them with. The central role is to ensure the process works as the parties have agreed it should...” Both installations also felt they had adequate control during the process. It is not appropriate to compare this with the practitioner answers as the practitioners play the role of the third party neutral and the installations are a party to the dispute. Control for the practitioners meant control of the process, while control for the installations meant they felt the dispute resolution process was free of external governmental influences.

Question 7d: Do you feel that the cases you consulted on resulted in win-win situation? Why or why not?

A majority of practitioners and both installations felt that their cases resulted in win-win situations. Practitioner #20, “When parties come through in an environmental situation and work together collaboratively, it’s always a win-win and there is always something that everybody’s given up.” One installation respondent noted that, even when all sides do not “win”, a focus on the process—honest attention to all positions and a clear explanation for all decisions—is important to preserving the settlement.

- *Question 7e: What steps can the military take to be more proactive in using ADR in environmental disputes?*



There were many responses to this question and the top three—being proactive, being open-minded and transparent, and being trained to apply ADR effectively—were mentioned by multiple practitioners. One installation echoed the need for open-mindedness and being proactive and the other installation noted the importance of maintaining a long-term focus.

Investigative Question 7—Conclusions.

In general, the barriers to implementing the ADR process in environmental disputes appear to be the absence of one or more of the key elements found in Figure 3. Without any Air Force environmental ADR case files to research or parties to interview, it is not apparent if the Air Force is missing one or more key elements in how it approaches the cases. An in-depth study of previous cases would be helpful in determining if any barriers are present.

The interviews with Air Force installation environmental personnel, Air Force RAB members and an interview with an Air Force environmental attorney all seem to indicate that formal ADR processes such as a Superfund case are not as prevalent as they were in earlier decades when cleanup of installations became a priority. Many issues are now being resolved at the base level through the collaborative RAB process.

Limitations of the Research

The nature of qualitative research is that it allows collecting rich, contextual data; in return, however, it sacrifices the ability to generalize the results with great confidence and the ability to make causal inferences (Leedy and Ormrod, 2001). The research methodology originally selected was the case study method but the inability to find actual environmental ADR cases or parties to interview limited the methodology to a simple exploratory qualitative study. The researcher tried to counteract the lack of cases or parties by continually looking for subjects with some environmental dispute experience to interview during the course of this research hence the installation questionnaire and the RAB board member experiences. Finally, despite the marginally satisfactory response rate (20%), the relatively few responses from base Installation Restoration personnel mean caution should be taken in viewing those bases as representative of the broader community.

Recommendations for Future Research

The use of ADR in military environmental disputes is a new research area. The results of this study have provided some areas for future researchers to consider:

- An in-depth study of any Air Force environmental ADR case files to explore how the process was initiated, how the process progressed, and the final resolution would help to determine if the key elements are present in the case and if any are not, whether their absence had an effect on the outcome.
- A more detailed study of Air Force IRP/RAB programs. What is being done at the base level to keep issues from escalating? Are there really that many environmental issues any more or is effective use of the IRP/RAB programs precluding their escalation?
- A study of the Army and Navy use of ADR in their disputes. The practitioners repeatedly mentioned the Army Corps of Engineers as their primary military



customer, and each of these services seems both to have a good working relationship with the EPA and to use ADR actively in their environmental disputes.

Final Summary

This study has attempted to provide the Air Force ADR Program Office with current information on the status of the use of ADR in environmental disputes. This preliminary research has provided that information through interviews with environmental conflict resolution practitioners, a questionnaire from two Air Force installations, and some opinions from RAB board members. The Program Office also wished to know how it could utilize ADR more in environmental disputes. This study has provided some of the key elements that appear to lead to a successful ADR process. Finally, this study has provided an area for further exploration to determine if there is an Air Force ADR process already in place in the structure of the IRP/RAB program.

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5 USC § 571 et seq. (1990).

28 USC § 471 et seq. (1990).



Panel -- Implementing an Open Systems Approach in Weapon System Acquisition

Wednesday, May 17, 2006	Implementing an Open Systems Approach in Weapon System Acquisition
3:15 p.m. – 4:45 p.m.	<p>Chair:</p> <p>CAPT James Shannon – Program Manager, Naval Open Architecture, PEO IWS 7.0</p> <p>Papers:</p> <p><i>Using a Modular Open Systems Approach in Defense Acquisitions: Implications for the Contracting Process</i></p> <p>Rene Rendon, Naval Postgraduate School</p> <p><i>Developing Performance-Based Requirements for Open Architecture Design</i></p> <p>Brad Naegle, Naval Postgraduate School</p> <p><i>Acoustic Rapid COTS Insertion—Case Study</i></p> <p>Mike Boudreau, Naval Postgraduate School</p>



Using a Modular Open Systems Approach in Defense Acquisitions: Implications for the Contracting Process

Presenter: Rene Rendon, PhD, is on the faculty of the Naval Postgraduate School where he teaches graduate acquisition and contract management courses. Prior to his appointment at the Naval Postgraduate School, he served for more than 22 years as an acquisition and contracting officer in the United States Air Force. His Air Force career included assignments as a contracting officer for major space and weapon systems. Rendon has earned Bachelor, Master's, and Doctorate degrees in Business Administration and has taught for the UCLA Government Contracts program. Dr. Rendon is the Chair of ISM's Federal Acquisition and Subcontract Management Group, a member of the ISM Certification Committee, as well as on the Editorial Review Board for the ISM *Inside Supply Management*. He is a member of the NCMA Board of Advisors, as well as associate editor for its *Journal of Contract Management*. Dr. Rendon has published articles in *Contract Management*, the *Journal of Contract Management*, *Program Manager*, *Project Management Journal*, and *PM Network*, and is co-author of *Contract Management Organizational Assessment Tools* published in 2005.

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Research Summary

This research explores the use of the modular open systems approach (MOSA) as a method for implementing an evolutionary acquisition strategy as well as the implications of using such an approach on the contracting process.

A background on evolutionary acquisition is provided highlighting the benefit of rapid development and production of weapon systems incrementally, with each increment providing an increasing level of capability. The modular open systems approach (MOSA) is identified as an enabler for the evolutionary acquisition strategy, and a brief discussion on open systems is provided.

The contractual implications of using a modular open systems approach is then discussed, focusing on each of the six phases of the procurement process. Examples of MOSA-specific contracting activities and documents are taken from recent US Navy weapons systems acquisition programs such as the Navy's Common Enterprise Display System (CEDDS) program, Anti-Submarine Warfare (ASW)/Undersea Warfare (USW) Test Information Management System program, Multi-mission Maritime Aircraft (MMA) program, Littoral Combat Ship (LCS) Mission Package Integrator program, Littoral Combat ship (LCS) Flight 0 Preliminary Design program, and the Navy's Mobile User Objective System (MUOS) program. The research will then conclude with the identification of characteristics of a successful MOSA program procurement and resulting contract.



Open Systems and Modular Open Systems Approach (MOSA)

The modular open systems approach is considered an enabler to successfully implementing an evolutionary acquisition strategy. While Evolutionary Acquisition focuses on rapidly developing and producing weapon systems incrementally, with each increment providing an increasing level of operational capability, the modular open systems approach ensures access to the latest technologies and products and facilitates affordable and supportable system development and modernization of fielded assets (Defense acquisition guidebook, 2004).

MOSA Principles

Program managers implementing an open systems approach should consider the five MOSA principles listed below and described in the Open Systems Joint Task Force Guide to MOSA (Defense acquisition guidebook, 2004; OSJTF guide, 2004).

1. Establish an Enabling Environment

This involves establishing supportive requirements, business practices, and strategies for technology development, acquisition, test and evaluation and product support needed for the effective development of open systems. Also included are the following: assigning responsibility for MOSA implementation, ensuring appropriate experience and training on MOSA, continuing market research and proactive identification, and overcoming of barriers or obstacles that can potentially slow down or even, in some cases, undermine effective MOSA implementation.

2. Employ Modular Design

Effective modular design refers to the four major modular design tenets of Cohesiveness (the module contains well-focused and well-defined functionality), Encapsulation (the module hides the internal workings of its behavior and its data), Self-Containment (the module does not constrain other modules), and Highly Binded (the modules use broad modular definitions to enable commonality and reuse). This principle states that by following these four tenets, each module will be designed for change, and the interface to each module will be defined in such a way as to reveal as little as possible about its inner workings which facilitate the standardization of modular interfaces.

3. Designate Key Interfaces

This principle stresses that designers should group interfaces into two categories—key and non-key interfaces. Such distinction enables designers and configuration managers to distinguish among interfaces that exist between technologically stable and volatile modules, between highly reliable and more frequently failing modules, between modules that are essential for net-centricity and those that do not perform net-centric functions, and between modules that pass vital interoperability information and those with least interoperability impact. Employing this principle will help acquisition managers effectively manage hundreds and, in some cases, thousands of interfaces that exist within and among systems.



4. Use Open Standards

This principle stresses that standards should be selected based on maturity, market acceptance, and allowance for future technology insertion. Since interface standards must be well defined, mature, widely used and readily available, the principle refers to the order of priority given to the use of open interfaces. Preference is given to the use of open interface standards first, the de facto interface standards second, and finally, government and proprietary interface standards. Basing design strategies on widely supported open standards increases the chance that future changes will be able to be integrated in a cost effective manner.

5. Certify Conformance

This principle focuses on the verification and validation of a system's openness through the use of such mechanisms as interface control and management as well as proactive conformance testing and certification. Using these mechanisms, the program manager ensures that the system and its component modules conform to the external and internal open interface standards allowing plug-and-play of modules, net-centric information exchange, and re-configuration of mission capability in response to new threats and evolving technologies. A preference is made for the use of the MOSA Program Assessment and Review Tool (PART) developed by the Open Systems Joint Task Force (OSTJ) to assess the compliance with open systems policies and ensure that acquisition programs are properly positioned to reap the open systems benefits (Defense acquisition guidebook, 2004).

Program offices should follow these five MOSA principles to guide their efforts in ensuring access to the latest technologies and products, achieving interoperability, and facilitating affordable and supportable modernization of fielded assets. Following these principles will also be needed to ensure delivery of technologically superior, sustainable, and affordable increments of militarily useful capability within an evolutionary acquisition strategy context. As program offices use these five MOSA principles to guide their implementation of a modular open system approach in their acquisition programs, the implications of these principles should permeate throughout all aspects of the acquisition process. One major area in which the MOSA strategy should have a significant influence is the contracting process. The implications of using a MOSA approach to acquisition and contracting will be discussed in the next section of this paper.

The next section of this research will focus on the various contractual documents prepared, contractual language developed, and contracting activities performed during the contracting process, as well as on the implications of using a modular open systems approach on those documents, language, and activities. This contracting process consists of the following phases—procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract closeout (Garrett & Rendon, 2005).

Procurement Planning

Procurement planning is the first contracting phase and involves identifying which business needs can be best met by procuring products or services outside the organization. This process involves determining whether to procure, how to procure, what to procure, how much to procure, and when to procure. Key practice activities included within the



procurement planning phase include determining the initial scope of work or the description of the product in the acquisition, conducting market research to analyze the level of technologies and types of products and services available in the marketplace, determining funds availability, and developing initial cost and schedule estimates as well as manpower resources. Developing an initial Statement of Work (SOW) and Work Breakdown Structure (WBS) are also included in the procurement planning phase. Conducting an initial integrated assessment of contract-type selection, risk management, and an initial analysis of potential contract terms and conditions is also part of the procurement planning process (Garrett & Rendon, 2005). It should be noted that many of the contractual documents developed in the procurement planning phase are initial draft documents, such as SOWs, WBSs, project scope statements, and funding and manpower estimates. These are initial draft documents simply because they are typically modified and revised as the acquisition program office becomes more knowledgeable of the business and technical aspects of the program. Industry business and technical knowledge are typically acquired through the use of market research activities, industry conferences, and Requests for Information (RFIs).

Market Research

Market research is a critical step in the acquisition of open systems-based programs. The Federal Acquisition Regulation (FAR) states that agencies must conduct market research appropriate to the circumstances before developing new requirements documents for an acquisition by that agency and before soliciting offers for acquisitions with an estimated value in excess of the simplified acquisition threshold (FAR 10). It is during this process that the buyer determines the availability of COTS products and open systems-based products, as well as determines if these available products will meet the specified acquisition requirements. Market research activities focus on acquiring knowledge of current market practices, technologies, capabilities, products, and future trends in areas related to the acquisition. Given the objectives of using a modular open systems approach, market research is extremely critical in leveraging commercial investment, enhancing access to cutting-edge technologies and products and increasing competition. Market research should also be used in an open systems-based acquisition to determine the capabilities of contractors to use open systems approaches and to comply with contractual requirements for using open systems approaches. A market research technique is the benchmarking of industry best practices related to the development and use of open systems in product development (Garrett & Rendon, 2005).

Industry Conferences

Industry conferences are also used for obtaining industry knowledge related to the development of the solicitation (as well as the acquisition in general). Industry conferences can provide valuable information in the areas of state of technologies and market practices concerning the use of open systems and the development of open systems architectures in product development and acquisition. Industry conferences serve two main purposes—to inform industry about the technical requirements and acquisition planning of the program and to solicit industry inputs for the pending program (Office of the Undersecretary of Defense (AT&L), 2005).



Request for Information

Requests for Information (RFIs) are used as a market research technique for the purpose of gathering information from industry to be used in planning an acquisition. Government agencies typically use RFIs as a source of information for understanding, developing, defining and refining the acquisition requirement. It should be noted that RFIs are not solicitation notices, nor do they commit the government to issuing a solicitation or even continuing with the acquisition. RFIs are also used as a method for identifying potential offerors for an upcoming acquisition. These types of RFIs are also known as Sources Sought Synopses.

Given the objectives of managing an acquisition using a modular open systems approach, RFIs, along with other market research techniques, are extremely valuable for acquiring knowledge of current market practices, technologies, capabilities, products, and future trends in areas related to the acquisition. This information will effectively support the MOSA objectives of leveraging commercial investment, enhancing access to cutting edge technologies and products, and increasing competition. RFIs can be effective in determining the capabilities of contractors to use open systems approaches and to comply with contractual requirements for using open systems approaches. RFIs can also provide information on a potential offeror's past performance in integrating technical and management processes in prior programs (Office of the Undersecretary of Defense (AT&L), 2005).

Solicitation Planning

The second phase of the procurement process is Solicitation Planning, which involves the process of preparing the solicitation documents needed to support the acquisition. This is a critical phase of the procurement process since it is during this phase that the work statements, specifications and other exhibits, standard terms and conditions, as well as special contract requirements are developed, revised, and finalized. Key practice activities within the solicitation planning process include using standard procurement forms and documents such as solicitation templates, model contracts, specifications and item descriptions, solicitation provisions, and contract terms and conditions (Garrett & Rendon, 2005). Federal Acquisition Regulations (FAR) require contracting officers to prepare solicitations and contracts using the FAR-specified uniform contract format to the maximum extent possible, as well as the required solicitations provisions and contract clauses

The solicitation for an acquisition program using an open systems approach will require specific language unique to the use of a modular open systems approach. Thus, the procurement documents that make up the solicitation should incorporate the specific language that reflects the preference or mandated use of a modular open systems approach in the acquisition program. Section C (Description/Specification/Statement of Work), Section L (Instructions, Conditions, and Notices to Offerors or Respondents), and Section M (Evaluation Factors for Award) are the primary parts of the solicitation that are influenced by the particular engineering approach to the acquisition program. These sections are the core of the solicitation and directly influence the offeror's proposal and the resulting contract.

It is the documents in this section that will be most effective in communicating the government's requirements for using an open systems approach in the acquisition. Thus, acquisitions that are using a modular open systems approach should have specific and unique documents and language within these solicitation sections and documents. The



procurement documents and specific solicitation language that will be discussed in this solicitation planning phase include Section C documents such as the Statement of Objective (SOO)/Statement of Work (SOW) and Preliminary System Specification, and Section L documents which consist of the Instruction to Offerors (ITOs). The discussion of the Source Selection phase of the contracting process will address Section M, Evaluation Factors for Award.

Section C of the solicitation consists of descriptions, specifications, and statements of work for the acquisition program. This section of the solicitation contains the detailed description of the products to be delivered or the work to be performed under the contract.

System Performance Specification

A critical Section C document is the performance specification. The system performance specification defines the government's performance requirements for the system and should reference any industry and approved military specifications and standards. Typically, the system performance specification in the solicitation is considered a "preliminary system performance specification," and the offeror responds to the solicitation with a formal system performance specification in its proposal. The solicitation must be clear in delineating whether the government will consider offeror-proposed revisions to the preliminary performance requirements that may be cost effective. The offerors run the risk of being declared non-responsive to the solicitation for proposing revised performance requirements (Office of the Undersecretary of Defense (AT&L), 2005). In acquisition programs using a modular open systems approach, the system performance specification plays a critical role in communicating the government's requirement for communicating "openness" and delineating requirements for open systems. Typically, the performance specification is developed using the requirements document that was the basis for initiating the acquisition. These requirements documents, such as the Operational Requirements Documents (ORD) or Capability Development Document (CDD), will be extensively used in developing the performance specification.

Statement of Work

Another critical document in Section C of the Solicitation is the Statement of Work (SOW). Traditionally, the government has used a SOW in its major acquisition programs. The solicitation Statement of Work (SOW) describes the actual work to be done by means of specifications or other minimum requirements, quantities, performance date, and requisite quality (Garrett & Rendon, 2005). The offerors propose their management, technical, and cost approach to meeting the requirements of the SOW in their proposal. Already a critical part of the solicitation package, the SOW takes on even more of a significant role in an acquisition using an open systems-based approach. In these acquisition programs, the SOW must be clear and concise in communicating the requirements that contractors must comply with in terms of meeting open systems standards and incorporating open system components in the development of the total system.

SOW specifically tells the contractor that a primary consideration in selection of equipment shall be the impact to the overall modular open systems architecture. Additionally, the SOW stresses the importance of long-term supportability, interoperability, and growth for future modifications as major factors in the contractor's selection of equipment. Furthermore, the SOW is specific in requiring the contractor to use an architectural approach that will provide a viable technology insertion methodology and



refresh strategy as well as to maximize commonality of components used in the CEDS equipment across all product baselines. Finally, the contractor is required to develop metrics to measure the degree of success in achieving the commonality goals (US Navy, 2005, September 9c).

The SOW in solicitations and resulting contracts for acquisition programs using an open systems approach is a critical tool for delineating the contractor's requirements and responsibilities in performing the contract.

Statement of Objectives

With the continued emphasis on Acquisition Reform and the streamlining of the acquisition process, many government agencies are now using a Statement of Objectives (SOO) instead of a SOW in the solicitation. The SOO is a government-prepared document incorporated into the RFP that states the overall objectives of the solicitation. Typically, the SOO is a very short document, usually under 10 pages, that clearly delineates the program objectives and the overall program approach of the acquisition. The purpose of the SOO is to provide the maximum flexibility to each offer to propose an innovative development approach (Garrett & Rendon, 2005). The offerors respond to the government's SOO with a SOW providing the details of its proposed management, technical, and cost approach for delivering the requirements of the acquisition. Therefore, instead of the government developing the SOW with detailed instructions and requirements, the government provides the SOO with only the top level objectives of the acquisition; the offerors then respond with the proposed detailed approach in their SOW. Thus, the use of the SOO by the government encourages offerors to propose innovative approaches and flexible design solutions (Meyers & Oberndorf, 2001). With this in mind, it can be clearly seen how SOOs definitely support the use of a modular open systems approach acquisition program.

Contract Data Requirements List (CDRL)

Another critical document in the solicitation is the Contract Data Requirements List (CDRL), DD Form 1423. The CDRL is a list of all authorized data requirements for a specific procurement that forms a part of the contract. CDRLs should be linked directly to the required tasks in the Statement of Work (SOW) (Office of the Undersecretary of Defense (AT&L), 2005). In relation to open systems and using an open systems approach in the acquisition, the government can request certain data or even demonstrations from the contractor, as part of the contract performance requirements.

Instructions to Offerors

In addition to the documents in Section C of the Solicitation, such as the System Performance Specification, SOO/SOW, and CDRL, specific language should also be included in Section L of the solicitation as well. Section L provides the Instructions to the Offerors (ITOs) for developing the proposals in response to the solicitation.

Section L of the solicitation specifies the format and content of proposals, as well as information or proposal preparation instructions that are not included elsewhere in the solicitation (Engelbeck, 2002). Acquisitions using a modular open systems approach have a critical need for providing specific instructions to offerors concerning the development of proposals and the offeror's adherence to the use of open systems in the development process. Typically, the ITOs reference other documents in the solicitation package such as



system technical architecture requirements and design guidance and standards for open architectures. The ITO typically specifies the factors to be used in the proposal evaluation phase of the source selection. These evaluation factors are traditionally categorized as technical, cost, and management. In acquisitions using a modular open systems approach, usually the technical evaluation factor specifies the ITO requirements related to the acquisition's open-systems requirements.

Solicitation

Solicitation is the third phase of the procurement process and is the process of obtaining bids and proposals from prospective sellers on how to meet the objectives of the project. The solicitation phase is critical to the overall acquisition strategy because it is this phase that executes the procurement planning strategy for a full and open competition or a sole source procurement. Some key practice activities within the Solicitation phase include conducting market research and advertising to identify new sources of supplies and services for the purpose of developing a list of interested offerors (Garrett & Rendon, 2005). These offerors will receive the solicitation requesting the proposal. Another key practice activity in the Solicitation phase includes conducting a pre-solicitation or pre-proposal conference to ensure that all prospective contractors have a clear, common understanding of the technical and contractual requirements of the acquisition (Garrett & Rendon, 2005). In this section on the Solicitation process, the use of Draft RFPs during the solicitation process and the implications of using a full and open competition or a sole source procurement strategy for open systems-based acquisitions will be discussed.

Draft RFPs

Typically, the process of issuing a solicitation and then later amending the solicitation to incorporate corrections, updated specifications, and revised language results in an extended and prolonged acquisition schedule. One of the goals of the solicitation process is to develop and structure a current and complete solicitation that will result in accurate, complete, and competitive proposals from prospective contractors in the shortest amount of time. The use of Draft RFPs has become a proven best practice in the solicitation planning process (Garrett & Rendon, 2005). Issuing a Draft RFP to interested offerors allows for additional industry feedback on any aspect of the proposed acquisition. With this "early and up-front" feedback from interested offerors to the contracting office, the contracting office can continue to improve and enhance the solicitation while it is still being developed, thus saving time and shortening the acquisition schedule.

Procurement Strategy

In developing a procurement strategy for an acquisition program, the traditional options include conducting a full and open competition or a sole source procurement. Statutory requirements, specifically 10 U.S.C. 2304 and 41 U.S.C. 253, require that contracting officers promote and provide for full and open competition in soliciting offers and awarding contracts (FAR, 6.101). There are certain statutory authorities permitting contracting without providing for full and open competition (sole source), as discussed in FAR 6.302. The benefit of full and open competition includes obtaining quality goods and services at a fair and reasonable price. Allowing all responsible offerors to compete also allows the government to leverage the forces of the marketplace to include leading technologies and innovative management approaches in developing solutions. Obviously, the benefits of pursuing a full and open competition fully support the objectives of managing



an acquisition program using an open systems approach. Since the underlying concepts of an open systems-based acquisition focus on the ability to insert cutting-edge technology as it evolves, the commonality and reuse of components among systems, the enhanced access to emerging technologies and products from multiple suppliers, the increased ability to leverage commercial investment, and an increase in competition, it would seem appropriate to pursue a full and open competition strategy for the acquisition. It should be noted that in some cases, especially at the platform level, the use of a full and open competition strategy is not possible.

The acquisition of the Virginia Class Submarine is an example of the need for other than full and open competition strategies.

A unique procurement strategy is the use of a “rolling down-select” procurement strategy approach. In this approach, a full and open competition is initially conducted, and multiple contracts are awarded. These contracts are typically used early in the acquisition lifecycle, such as for the development of preliminary designs. Once the designs have been submitted and evaluated, a down-select of the initial contractors to a single contractor is conducted for the development and production of the actual system. The acquisition strategy may involve multiple “down-selects,” depending on how many evaluation phases the buyer desires. For example, there may be an initial full and open competition for conceptual development contracts, a down-select to a smaller number of the original contractors for preliminary designs, another down-select to even a smaller number of contractors for prototype development, and finally, a final down-select to a single contractor for full development and production of the actual system.

As previously stated, the benefits of pursuing a full and open competition fully support the objectives of using an open systems approach in an acquisition program. Opening the acquisition to allow all qualified offerors to participate enables the government to enhance access to cutting-edge technologies and products from multiple suppliers, to have the ability to insert cutting-edge technology as it evolves, and to have the increased ability to leverage commercial investments in technology. Of course, at some point in time, the government will need to establish a relationship with one contractor; otherwise having multiple contractors producing the same system may be cost prohibitive. The major issue is determining how many contracts to award following a full and open competition and how to structure the “down-select” process to determine the single production contractor.

Source Selection

Source Selection is the fourth phase of the contracting process and involves the process of receiving proposals and applying evaluation criteria to select the contractor. Key practice activities within the source-selection process include using evaluation criteria focusing on management, technical, and cost, tailoring the basis for award to either lowest cost/technically acceptable or best value, and taking into consideration an offeror’s past performance in evaluating proposals (Garrett & Rendon, 2005).

Evaluation Factors

Section M of the solicitation specifies how the buyer will evaluate the factors identified in the Instructions to Offerors (ITO) in Section L. As previously stated, Section L specifies the factors to be used in the proposal evaluation phase of the source selection, while Section M specifies how the factors will be used in the proposal evaluation process.



These evaluation factors are traditionally categorized as technical, cost, and management. In acquisitions using a modular open systems approach, it is usually the technical evaluation factor that specifies the ITO requirements related to the acquisition's open system requirements. The relationship between cost and non-cost factors (such as quality, technical, and past performance), as well as how they will be used in the source-selection decision, are described in Section M. The two major evaluation strategies are Lowest Price/Technically Acceptable (LPTA) or best value. Best value refers to an evaluation strategy where trade-offs are made in relation to cost and other factors. Thus, in an LPTA source selection, the offeror proposing the lowest price, technically acceptable offer will be awarded the contract. However, in a best-value source selection, the contract award may be made to "other than the lowest priced, technically acceptable offeror," based on a trade-off among cost, technical, and past performance factors. It is important that the proposal evaluation strategy should be tailored to meet the objectives of the acquisition strategy (Garrett & Rendon, 2005). The use of the best-value evaluation strategy is appropriate for acquisitions that involve requirements that are less definitive, require more development work, or the acquisition has greater performance risk, and where more technical or past performance considerations play a dominant role in the source-selection decision (FAR, 15.101). Obviously, an acquisition that involves the use of a modular open systems approach in the development of the system would involve a less definitive requirement, require more development work, have greater performance risk, and involve more technical or past performance considerations playing a dominant role in the source-selection decision. Thus, the use of a best value evaluation approach is desired for these types of acquisitions (Meyers & Oberndorf, 2001).

When using the best-value trade-off process, it is important for all evaluation factors and significant sub-factors that will affect contract award and their relative importance to be clearly stated in the solicitation; and the solicitation should state whether all evaluation factors other than cost or price, when combined, are significantly more important than, approximately equal to, or significantly less important than cost or price. This process permits trade-offs among cost or price and non-cost factors and allows the government to accept other than the lowest priced, technically acceptable proposal (FAR, 15.101-1).

Basis for Award

Even more critical in acquisition programs using a MOSA approach is the language used for the basis for award. The basis for award describes the government's method for selecting the contractor. The most critical part of the basis for award language is the weight, or relative importance, given to the various proposal evaluation factors. It is this specific language in which the buyer communicates to the offerors the priority, or relative importance, of the evaluation factors. Acquisition of modular open systems approach-based programs should be specific in communicating the relative importance of the evaluation factors. In addition, and more importantly, acquisition of modular open systems approach-based programs should place greater importance on proposal evaluation factors related to technical-related factors.

The source-selection process is obviously critical to the overall acquisition program. It is in this phase where the offeror's proposal is evaluated to determine the best value for the government. It should be noted that the Instructions to Offerors (ITOs) in Section L and the evaluation factors and criteria stated in Section M of the solicitation must be consistent and interrelated. These are the areas carefully scrutinized by offerors in making their bid/no bid determination, as well as in developing their proposals. In addition, the evaluation



factors and criteria should be tailored to meet the objectives of the acquisition strategy (Garrett & Rendon, 2005). In acquisition strategies that are based on the use of a modular open systems approach, it is critical that Sections L and M are carefully crafted and structured to communicate and incentivize the offerors to develop management, technical, and cost approaches appropriate for achieving the open systems goals of the acquisition.

Once the contract is awarded, the government and contractor relationship then shifts to a performance measurement and management focus in which the government manages the contractor's performance to ensure that acquisition objectives are achieved. One way of ensuring the contractor meets these acquisition objectives is through the use of appropriate contract types and contract incentives, which are administered during the contract administration phase of the acquisition. This is discussed in the next section of this report.

Contract Administration

Contract Administration is the fifth phase of the contracting process and entails managing the relationship with the contractor and ensuring that each party's performance meets the contract requirements. During contract administration, the government's focus is on managing the contractor's cost, schedule, and performance. Key practice activities within the contract administration process include using an integrated team approach for monitoring the contractor's cost, schedule, and performance, and having an established process for administering incentive and award-fee provisions (Garrett & Rendon, 2005). These incentives and award fees are tools used to motivate and incentivize the contractor to meet specific performance standards of the contract. These incentive techniques will be discussed in more depth later in this section.

Although the purpose of this report is not to present a full discussion on the various contract types and contract incentives, a brief description of the major categories of contract types and related contract incentives will be presented. The purpose here is to briefly identify which contract types and contract incentives have been previously used in acquisition programs pursuing a modular open systems approach. References will be made to a recent assessment of acquisition programs by the Navy Open Architecture Enterprise Team (OAET) in support of the Navy Program Executive Office-Integrated Weapon System (PEO-IWS) (US Navy, 2005, September 27).

Contract Types

The Federal Acquisition Regulation (FAR) identifies two major contract categories: cost reimbursement contracts and fixed-price contracts (FAR, 16). These contract-type categories refer to the method of compensation due to the contractor for the performance of the contract.

In the Fixed-price Contract category, the contractor agrees to provide specified supplies or services in return for a specified price, either a lump sum or a unit price. In addition, the price is fixed and is not subject to change regardless of the contractor's actual cost experience. Only if the contract is modified is the price subject to change (Garrett & Rendon, 2005). There are various types of fixed-priced contracts such as Firm Fixed Price (FFP), Fixed Price with Economic Price Adjustment (FP-EPA), and Fixed Priced Incentive (FPI).



In the Cost Reimbursement contract category, the contractor agrees to provide a best effort in performing the requirements of the contract, which is typically broadly defined in terms of specifications. In return, the contractor is reimbursed for all allowable costs up to the amount specified in the contract. Cost allowability is governed by the FAR (FAR, 31). Various types of Cost Reimbursement contracts include Cost Sharing (CS), Cost Plus Fixed Fee, (CPFF), Cost Plus Incentive Fee (CPIF), and Cost Plus Award Fee (CPAF).

Contract Incentives

Contracts may include incentives to provide additional motivation to the contractor for meeting or exceeding certain cost, schedule, or performance objectives. Contract incentives are basically of two types—objectively based incentives and subjectively based incentives.

Objectively based incentives use a pre-determined formula to determine the rewards (increase of profit or fee) or the penalties (reduction of profit or fee) due to the contractor. Examples of objectively based incentives include Fixed-priced Incentive and

Cost Plus Incentive Contracts

Subjectively based incentives include Award Fee or Award Term contracts. These incentives use a subjective evaluation to determine if any additional fee or term (for service contracts) is due to the contractor. Based on a subjective evaluation of the contractor's effort to exceed specific requirements in terms of cost, schedule or performance as specified in the Award Fee Plan or Award Term Plan, the contractor may be entitled to earn additional fee or term on the contract.

The biggest challenge in using incentive contracts and award fee/term contracts is the ability to structure an effective incentive tool that will successfully motivate the contractor to perform in specified areas and exceed the performance requirements. It is particularly important to structure appropriate incentive arrangements that will result in the contractor applying additional emphasis in the areas important to the government. In acquisition programs using a modular open systems approach, the government will want to incentivize the contractor to meet higher levels of "openness" in the design and development of the system.

Acquisition programs using a modular open systems approach are challenged with incentivizing the contractor to achieve the required levels of "openness" by meeting or exceeding the technical requirements of the contract, as well as cost and schedule requirements. The Award Fee type of incentive has been traditionally used for motivating the contractor to excel in technical performance. All of the programs referenced in conducting this research used the Award Fee process as a tool for incentivizing the contractor to achieve a certain level of openness in the design and development of the weapon system

A new type of incentive tool that is currently very successful is the Award Term incentive. Award Term is similar to Award Fee; it differs only in that an Award Term contract ties the length of the contract's period of performance to the performance of the contractor. Contractors with good performance may have the term of the contract extended, or contractors with poor performance may have the contract term reduced (Garrett & Rendon, 2005).



The selection of contract types and contract incentives requires careful planning, implementation, management, and measurement to ensure its success in incentivizing contractors and improving performance (Garrett & Rendon, 2005). Programs that are encouraging the use of a modular open systems approach in the development of the system should incorporate Award Fee and Award Term incentives. This is especially true when a Statement of Objectives (SOO) is used to describe the government's required outcomes and overall objectives and when the contractor has the flexibility to be innovative in proposing its management and technical approach towards meeting those outcomes and objectives.

Contract Closeout

The final phase of the contracting process is Contract Closeout. Contract Closeout is the process of verifying that all administrative matters are concluded on a physically complete contract. This involves accepting final deliveries and making final payment to the contractor, as well as completing and settling the contract and resolving any open items. Key practice activities within the contract closeout phase include using checklists and forms for ensuring proper documentation of closed contracts and maintaining a "lessons learned and best practices" database for use in future contracts and projects (Garrett & Rendon, 2005). The contract closeout phase is often forgotten and has traditionally been considered an administrative burden or relegated to a clerical or non-essential task. An important aspect of completing and closing out the contract is conducting a final evaluation of the contractor's performance on the contract in terms of meeting cost, schedule, and performance objectives. This final contractor evaluation will be used as a past-performance evaluation of the contractor in future contract competitions and source selections.

As previously stated, contractor past performance is a critical evaluation factor for major source selections and is listed as an evaluation factor under Section M of the solicitation. Ensuring the final contractor performance evaluation is completed during the contract closeout process is critical in ensuring that information is available for use in a future source selection. In acquisitions using a modular open systems approach, a critical proposal evaluation factor listed in Section M of the solicitation should be the contractor's past performance and recent experience in working in an open systems approach environment. Past performance is a mandatory proposal evaluation criterion for major source selections in accordance with FAR 15.304. The Department of Defense (DoD) uses the Contractor Performance Assessment Report (CPAR) to conduct periodic and final evaluation of the contractor's performance. Systems engineering is a major contractor past-performance assessment element, and the CPAR should be used to evaluate the contractor's adherence to open systems standards and MOSA requirements on open systems-based acquisitions. Using the CPAR evaluation tool, the government can document excellent or poor contractor performance in terms of meeting contract "openness" requirements, and this documentation can then be used in future source selections (Office of the Undersecretary of Defense (AT&L), 2005).

Summary, Conclusions, and Recommendations

The research identified the following characteristics of a successful MOSA program procurement and resulting contract: Early involvement and participation of industry in the development of requirements and acquisition strategy; shared roles between the government and contractors in the development of the system specification and statement of work; the use of a best-value contract strategy consisting of the evaluation of offeror's



technical, schedule, and past performance, as well as the offeror's cost and management approach; the use of a contract structure consisting of contractor incentives for meeting higher levels of "openness"; the documentation of contractor's past performance in meeting "openness" requirements, as well as the documentation of lessons learned and best practices on open systems.

Finally, the report recommends that further research be conducted on the following areas: Other DoD acquisition programs to evaluate the extent to which the identified MOSA contracting best practices and characteristics have been implemented in those departments; the effectiveness of award fee and award term provisions in incentivizing contractors to achieve higher levels of openness in designing and developing weapon systems, given the recent GAO findings concerning the use of award fees in DoD contracts; an analysis of current major weapon system acquisition programs status of MOSA implementation that is a required milestone review briefing point to the program's Milestone Decision Authority; the results of any OSJTF Program Assessment Rating Tool (PART) internal MOSA assessments on current defense acquisition programs; and, finally, the type and extent of training that is currently provided to contracting officers in the area of MOSA-based acquisition strategies.

This is an abbreviated version of the complete research report. The complete research report may be accessed from the Naval Postgraduate School website www.nps.navy.mil/gsbpp/acqn/publications.

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Developing Performance Based Requirements for Open Architecture Design

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Abstract

To implement the capabilities conceptualized in *Joint Vision 2020*, complex, secure networks of weapon systems, intelligence platforms, and command and control mechanisms must be seamlessly integrated and maintained over time. Accurate and timely information will enable *Joint Vision 2020* key tenets: Dominant Maneuver, Precision Engagement, Focused Logistics, and Full Dimensional Protection. These networks are central warfighting platforms in the information age.

As these capabilities are developed over time in an evolutionary manner, interoperability on the Net-Centric Warfare (NCW) networks is essential, and both hardware and software systems must be designed in an Open-systems Architecture (OA) fashion to accommodate the vast number of changes anticipated. Professional Program Management will be needed to successfully develop these key warfighting platforms.

Materiel Developers will need to recognize the relatively immature nature of the software engineering domains and actively compensate for this immaturity. System software performance capabilities must be much more detailed than typical hardware-centric systems, as the current state of software engineering disciplines is unlikely to satisfy implied, yet critical performance requirements. Essential OA performance characteristics including Maintainability, Upgradability, Interfaces/Interoperability, Reliability, Safety and Security (MUIRSS) must be fully analyzed and clearly communicated to the software developer to ensure the DoD obtains the flexibility and longevity desired from NCW systems.

Keywords: Net-Centric Warfare, Interoperability, Open Systems Architecture, Software Requirements, System of Systems, Family of Systems



Introduction

Joint Vision 2020 is the Chairman of the Joint Chiefs of Staff's guiding document for development of the future force and warfighting capabilities. It states, "If our Armed Forces are to be faster, more lethal, and more precise in 2020 than they are today, we must continue to invest in and develop new military capabilities." It continues, dictating, "The overall focus of this vision is full spectrum dominance—achieved through the interdependent application of dominant maneuver, precision engagement, focused logistics, and full dimensional protection" (CJCS, 2000, pp. 1-2). The key word is "interdependent," as it prescribes interoperability requirements to a level never before achieved. Flexible networks of complex system-of-systems must be successfully developed to realize this vision.

To implement the concepts presented in *Joint Vision 2020*, the Director of Force Transformation anticipates a new era:

As the world enters a new millennium, our military simultaneously enters a new era in warfare—an era in which warfare is affected by a changing strategic environment and rapid technological change. The United States and our multinational partners are experiencing a transition from the Industrial Age to the Information Age. Simultaneously, we are fully engaged in a global war on terrorism set in a new period of globalization. These changes, as well as the experiences gained during recent and ongoing military operations, have resulted in the current drive to transform the force with network-centric warfare (NCW) as the centerpiece of this effort. (2005, p. 3)

This quote from *The Implementation of Network-centric Warfare* clearly indicates the direction that the DoD is taking in developing the next generation's warfighting capabilities. The success of the initial NCW systems deployed since Desert Storm, as limited as they were, revealed the potential battlespace domination offered through networked systems providing situational and information superiority. One major challenge in constructing effective NCW systems is designing the network to seamlessly integrate existing, planned and future platforms and systems into a secure, fully interoperable, near real-time information system. The network will need to accommodate complex systems that may or may not have been designed to interoperate. The networked systems themselves are extremely complex and will have been developed decades apart. The network design must be open, flexible and able to adapt to this wide disparity of system-of-systems.

It is well understood that an Open-systems Architecture (OA) design is required to meet both current and future warfighting needs and is a critical element in net-centric warfare systems-of-systems concepts. These highly integrated systems are increasingly dependent on software solutions for integration into the net-centric scheme; therefore, software interfaces are one of the main keys for achieving the tactical and strategic synergies of the net-centric system. This paper will focus on the challenges presented when the Department of Defense (DoD) conducts capabilities analysis and derives performance specifications for a software-intensive, net-centric, system-of-systems architecture that meets OA needs throughout the life of the system.

You got to be careful if you don't know where you're going, because you might not get there! – Yogi Berra



The DoD Performance Specification development process transforms the warfighter requirements into terms that are more understandable for the system developer, usually the prime contractor. Typically, the system performance requirements are decomposed through at least three levels using the Work Breakdown Structure (WBS) methodology. The concept is to provide the contractor sufficient detail with regard to performance, constraints, and intended environments without stifling innovative solutions to meeting those requirements. The number of WBS levels developed by the DoD is dependent on the complexity of the system and the engineering domain maturity. For example, the automotive engineering discipline is very mature, and a level three WBS for a tactical truck system would most probably be sufficient. To determine whether the WBS is ready to hand off to a contractor, the Materiel Developer must continue WBS development to a point where either the contractor has enough information to develop the system needed by the warfighter, or any contractor derived solution that meets the stated performance requirements is acceptable. While easily stated, this presents a daunting challenge in complex systems, especially those that are software-intensive.

Software engineering is not mature, and there are few industry-wide standards for languages, tools, architectures, reuse, or procedures. Software developed for complex weapon systems is typically started from scratch with each new system; very little existing software code is reused. In addition, new languages and associated tools are introduced every few years. For this and other reasons, software programs grow exponentially in size and complexity, expanding desired capabilities but limiting the maturation process. The DoD Materiel Developer must recognize the relative immaturity of software engineering when developing the WBS for software-intensive systems and, more importantly, compensate for that immaturity.

The current state of software engineering maturity drastically impacts an area of extreme DoD concern—Supportability. Hardware-centric performance specifications rely heavily on mature engineering environments to account for a significant portion of the system's supportability performance. Using the automotive engineering example, there is little need of specifying supportability requirements such as features for oil, filter, tire and coolant replacement as they are industry-standard features that would be included in any competent design. There are few corresponding software engineering standards for supportability features, and most commercially based software is not designed for long-term use as is typically the requirement for DoD systems. There are literally hundreds of ways to build the architecture and construct the code for even the most basic software function. Without physical or established engineering techniques, the software developer is bounded only by his or her imagination and creativity in satisfying broad specifications. The resulting software may function correctly, but may not possess the OA design needed to effectively maintain, upgrade, or interface it with the constantly changing net-centric systems and environment.

DoD acquisition professionals must recognize that the warfighter capabilities needed require software development techniques that differ significantly when compared to their commercially based counterparts. The software engineering techniques used in short-lived software products may not prove effective in developing long-lived DoD software-intensive, warfighting systems. DoD systems are designed to have a very long life span, including software-intensive systems, in direct contravention with most commercially based software designs. The need for OA design—upgradeable, flexible, and highly reliable software that is maintainable over a long life span—is paramount to DoD's warfighting systems, but industry-standard software engineering techniques do not necessarily incorporate those features.



What this means to the DoD is that the capabilities analysis and resulting system performance specifications must be completed in significantly more detail to achieve software performance that meets warfighter's needs. The software developer needs to be driven to OA design by the performance specifications because software engineering discipline and state of the practice are unlikely to provide sufficient architectural designs without explicit performance requirements clearly communicated. Providing more detailed performance specifications seems to run counter to acquisition reforms implemented to allow industry flexibility and innovation in achieving performance thresholds and goals, but that is not the intent. The detailed performance specifications provide the software developer much more information about areas that the customer—the DoD—sees as critical to the overall system performance. This will have a significant impact on the system software design supporting OA performance and will provide the basis for a much more accurate cost and schedule estimate in the proposal received.

Near-term Challenges

The net-centric warfare concepts feature system-of-systems in an elaborate network requiring a significant number of critical interfaces. As each system is added or later upgrades its capabilities, it likely drives an interface change with other interfaced systems, necessitating the need for flexibility in accommodating interface changes from affected interoperating or networked systems. It is easy to visualize dozens of software changes driven by upgrades in the interfaced components of the network and the critical need for effective OA designs to quickly and economically accommodate change over a long life span. Again, this level of design flexibility is not a software industry norm for most commercially designed systems.

Safety and Security requirements for DoD weapon system software have few commercial counterparts. Obviously, commercially based critical medical equipment, aviation systems, and banking systems would also require a high degree of safety and security, but the combat environment weapon systems are intended to operate within, and the military lives that are always at stake adds to criticality of the need. The net-centric warfare environment will necessarily require unprecedented security measures. Software must be designed to continue to operate critical weapon systems in degraded modes, reject spurious input without freezing or failing, and resist intrusion, viruses and other attacks. Anything short of that will put military members and the critical missions they perform at risk. Most commercially based software engineering disciplines do not consider such stringent safety and security requirements. The system's OA design must allow for the flexibility needed while simultaneously ensuring safety and security requirements. These two forces are rarely in concert and usually are in conflict.

Considering the state of immature software engineering that exists today, it is clear that the DoD will not achieve the level of software-intensive system performance necessary if the WBS and performance specification are not developed more fully before hand-off to the developer or contractor. Due to the pressure to shorten the acquisition timeline, there is a tendency to rush the Request for Proposal (RFP) to the prospective contractors without developing the WBS below level three or including the performance specification with sufficient detail. This approach works with systems based in mature engineering environments as the contractor understands that all of those unstated requirements will be satisfied through the established engineering standards; thus, the proposed schedule and cost estimates will be fairly accurate. With a software-intensive system, this is not the case



due to many of the reasons presented earlier. The most diligent contractor can only provide cost and schedule estimates based on what is presented in the RFP. If a significant portion of the software development effort is not evident in the RFP, the contractor estimates may be grossly understated, causing substantial—and avoidable—funding shortfalls and schedule overruns that plague the development effort throughout the acquisition phase and well into the system's lifecycle.

A Methodology for Software OA Capabilities Analysis

For DoD software-intensive systems to attain the broad spectrum of warfighter performance and long-term supportability with predictable costs and schedules, the Materiel Developer must provide performance specifications in the RFP that are detailed in areas that hardware-centric systems with mature engineering environments need not be. In addition to the system's software performance issues, the OA areas of Maintainability, Upgradeability, Interfaces/Interoperability, Reliability, Safety, and Security (MUIRSS) must be carefully analyzed to ensure that the potential contractors understand the Government requirements and constraints in each of these areas. It is likely that the WBS will have to be developed several more levels in order to capture essential requirements; potential contractors would need to see such WBS development to form a realistic proposal with an executable schedule and an accurate cost estimate.

The Systems Engineering Process (SEP) is the preferred technique for analysis within each of the MUIRSS categories as it provides a highly structured and comprehensive methodology for developing the WBS. This will be a key tool for the DoD Materiel Developer in developing capabilities requirements and communicating them to the software developer via the performance specifications. Recognizing the existing shortfalls in software engineering maturity, this methodology will greatly assist the software developer in understanding OA-related performance requirements; this, in turn, will significantly influence the software architecture design and the level of effort estimated to build the desired system. The alternative leaves the software developer estimating these requirements without the background or experience to do so, or worse yet, discovering the extent of the actual requirements after the work has begun.

The capabilities analysis process must capture the OA performance needed for supporting the system throughout its lifecycle. This analysis should drive a robust Post Production Software Support (PPSS) plan addressing the MUIRSS elements of the OA design. The MUIRSS elements are interdependent and tend to apply across the system and software architecture. Each MUIRSS element is discussed in the following paragraphs to provide a basis for analyzing capability requirements within the area and capturing performance characteristics that are essential to the DoD.

Maintainability

The amount of elapsed time between initial fielding and the first required software maintenance action can probably be measured in hours, not days. The effectiveness and efficiency of these required maintenance actions is dependent on several factors, but the software architecture that was developed from the performance specifications provided is critical. The DoD must influence the software architecture through the performance specification process to minimize the cost and time required to perform essential maintenance tasks.



Maintenance is one area where software is fundamentally different from hardware. Software is one of the very few components where we know that the fielded product has shortcomings, and we field it anyway. There are a number of reasons why this happens; for instance, there typically is not enough time, funding or resources to find and correct every error, glitch, or bug, and not every one is worth the effort of correcting. Knowing this, there must be a sound plan and resources immediately available to quickly correct those shortcomings that do surface during testing and especially those that arise during warfighting operations. Even when the system software is operating well, changes and upgrades in other, interfaced hardware and software systems will drive some sort of software maintenance action to the system software. In other words, there will be a continuous need for software maintenance in the planned complex system-of-systems architecture envisioned for net-centric warfare.

Because the frequency of required software maintenance actions is going to be much higher than in other systems, the cost to perform these tasks is likely to be higher as well. One of the reasons for this is that software is not maintained by "maintainers," as are most hardware systems, but is maintained by the same type of people that originally developed it—software engineers. These engineers will be needed immediately upon fielding, and a number will be needed throughout the lifespan of the system to perform maintenance, add capabilities, and upgrade the system. There are several models available to estimate the number of software engineers that will be needed for support; planning for funding these resources must begin very early in the process. As the DoD has a very limited capability for supporting software internally, typically, early software support is provided by the original developer and is included in the RFP and proposal for inclusion into the contract or as a follow-on Contractor Logistics Support (CLS) contract.

Upgradeability

A net-centric environment composed of numerous systems developed in an evolutionary acquisition model will create an environment of almost continuous change as each system upgrades its capabilities over time. System software will have to accommodate the changes and will have to, in turn, be upgraded to leverage the consistently added capabilities. The software architecture design will play a major role in how effective and efficient capabilities upgrades are implemented, so communicating the known, anticipated and likely system upgrades will impact how the software developer designs the software for known and unknown upgrades.

Trying to anticipate upgrade requirements for long-lived systems is extremely challenging to Materiel Developers, but is well worth their effort. Unanticipated software changes in the operational support phase cost 50 to 200 times the cost in early design; so, any software designed to accommodate an upgrade that is never realized costs virtually nothing when compared to changing software later for a capability that could have been anticipated. For example, the Army Tactical Missile System (ATACMS) Unitary was a requirement to modify the missile from warhead air delivery to surface detonation—that is, flying the warhead to the ground. The contract award was for \$119 million for the modification. The warhead was not new technology, nor particularly challenging to integrate with the missile body. The vast majority of this cost was to reengineer the software to guide the missile to the surface. Had there been an upgrade requirement for this type of mission in the original performance specification, this original cost (including potential upgrades,



even if there were ten other upgrade requirements that were never applied) would have been a fraction of this modification cost.

Interfaces/Interoperability

OA design focuses on the strict control of interfaces to ensure the maximum flexibility in adding or changing system modules, whether they are hardware or software in nature. This presupposes that the system modules are known—which seems logical, as most hardware modules are well defined and bounded by both physics and mature engineering standards. In sharp contrast to hardware, software modularity is not bounded by physics, and there are very few software industry standards for the modular architecture in software components. This is yet another area where the software developer needs much more information about operational, maintenance, reliability, safety and security performance requirements, as well as current, planned and potential system upgrades. These requirements, once well-defined and clearly communicated, will drive the developer to design a software modular architecture supporting OA performance goals. For example, if a system uses a Global Positioning System (GPS) signal, it is likely that the GPS will change over the life of the system. Knowing this, the software developer creates a corresponding discrete software module that is much easier and less expensive to interface, change and upgrade as the GPS system does so.

With the system software modular architecture developed, the focus returns to the interfaces between hardware and software modules, as well as the external interfaces needed for the desired interoperability of the net-centric force. Software is, of course, one of the essential enablers for interoperability and provides a powerful tool for interfacing systems, including systems that were not designed to work together. Software performing the function of "middleware" allows legacy and other dissimilar systems to interoperate. Obviously, this interoperation provides a significant advantage, but comes with a cost in the form of maintainability, resources and system complexity. As software interfaces with other components and actually performs the interface function, controlling it and ensuring the interfaces provide the desired OA capability becomes a major software-management and software-discipline challenge.

One method being employed by the DoD attempts to control the critical interfaces through a set of parameters or protocols rather than active management of the network and network environment. This method falls short on several levels. It fails to understand and control the effects of aggregating all of the systems in a net-centric scheme. For instance, each individual system may meet all protocols for bandwidth, but when all systems are engaged on the network, all bandwidth requirements are aggregated on the network—overloading the total bandwidth available for all systems. In addition, members of the Software Engineering Institute (SEI) noted:

While these standards may present a step in the right direction, they are limited in the extent to which they facilitate interoperability. At best, they define a minimal infrastructure that consists of products and other standards on which systems can be based. They do not define the common message semantics, operational protocols, and system execution scenarios that are needed for interoperation. They should not be considered system architectures. For example, the C4ISR domain-specific information (within the JTA) identifies acceptable standards for fiber channels and radio transmission interfaces, but does not specify the common semantics of messages to be communicated between C4ISR systems, nor does it define an



architecture for a specific C4ISR system or set of systems. (Morris, Levine, Meyers, Place, & Plakosh, 2004, p. 38)

Clearly, understanding and controlling the interfaces is critical for effective interoperation at both the system and system-of-systems level. The individual program manager must actively manage all systems' interfaces impacting OA performance, and a network PM must do the same for the critical network interfaces. Due to this necessity of constant management, a parameters and protocols approach to net-centric OA performance is unlikely to produce the capabilities and functionality expected by the warfighter.

Understanding the software interfaces begins with the software architecture; controlling the interfaces is a unique challenge encompassing the need to integrate legacy and dissimilar systems and the lack of software interface standards within the existing software engineering environment. As stated earlier, the architecture needs to be driven through detailed performance specifications, which will help define the interfaces to be controlled. An effective method for controlling the interfaces is to intensely manage a well-defined Interface Control Document (ICD), which should be a Contract Data Requirements List (CDRL) deliverable on any software-intensive or networked system.

Reliability

While the need for highly reliable weapon systems is obvious, the impact on total system reliability of integrating complex software components is not so obvious. Typically, as system complexity increases, maintaining system reliability becomes more of a challenge. Add the complexity of effectively networking a system-of-systems (all of which are individually complex) to a critical warfighting capability that is constantly evolving over time, and reliability becomes daunting.

Once again, the software developer must have an understanding of reliability requirements before crafting the software architecture and developing the software applications. Highly reliable systems often require redundant capability, and this holds true for software components as well. In addition, software problems tend to propagate, resulting in a degradation of system reliability over time. For example, a Malaysian Airlines Boeing 777 suffered several flight control problems resulting in: a near stall situation, contradicting instrument indications, false warnings, and difficulty controlling the aircraft in both autopilot and manual flight modes. The problem was traced to software in an air data inertial reference unit that was feeding erroneous data to the aircraft's primary flight computer (PFC), which is used in both autopilot and manual flight modes. The PFC continued to try to correct for the erroneous data received, adjusting flight control surfaces in all modes of flight, displaying indications that the aircraft was approaching stall speed and overspeed limits simultaneously, and causing wind shear alarms to sound close to landing (Dornheim, 2005, p. 46). It is critical for system reliability that the software developers understand how outputs from software applications are used by interfaced systems so that appropriate reliability safeguards can be engineered into the developed software.

Software that freezes or shuts down the system when an anomaly occurs is certainly not reliable nor acceptable for critical weapon systems; yet, these characteristics are prevalent in commercially based software systems. Mission reliability is a function of the aggregation of the system's subcomponent reliability, so every software subcomponent is contributing to or detracting from that reliability. The complexity of software makes understanding all failure modes nearly impossible, but there are many techniques that



software developers can employ when designing the architecture and engineering the applications to improve the software component reliability. Once requirements are clearly communicated to the developers, the software can be engineered with redundancy or "safe mode" capabilities to vastly improve mission reliability when anomalies occur. The key is identifying the reliability requirements and making them clear to the software developers.

Safety

Very few software applications have the required safety margins associated with critical weapon systems used by warfighters in combat situations—where they are depending on these margins for their survival. Typically, the software developers have only a vague idea of what their software is doing and how critical that function is to the warfighter employing the weapon system. Safety performance must be communicated to the software developers from the beginning of development so they have the link between software functionality and systems safety. For example, suppose a smart munition senses that it does not have control of a critical directional component, and it calculates that it cannot hit the intended target. The next set of instructions the software provides to the malfunctioning system may well be critical to the safety of friendly troops, so software developers must have the necessary understanding of operational safety to decide how to code the software for what will happen next.

Software safety is clearly linked with reliability, as software that is more reliable is inherently safer. It is critical that the software developer understands how the warfighter expects the software to operate in abnormal situations, degraded modes, and when inputs are outside of expected values. Much commercially based software simply ceases to function under these conditions or gives error messages that supercede whatever function was being performed, none of which are acceptable in combat operations.

Security

With software performing so many critical functions, there is little doubt that software applications are a prime target for anyone opposing US and Allied forces. Critical weapon system and networking software must be resistant to hacking, spoofing, mimicking, and all other manner of attack. There must be capabilities of isolating attacks and portions of networks that have been compromised without losing the ability to continue operations in critical combat situations. The software developer must know all these capabilities are essential before he/she constructs software architectures and software programs, as this knowledge will be very influential for the software design and application development.

Interoperability challenges are increased when the system-of-systems have the type of security requirements needed by the DoD. Legacy systems and existing security protocols will likely need to be considered before other security architecture can be effectively designed. OA capabilities will be hampered by the critical need for security; both must be carefully balanced to optimize system performance and security. This balance of OA and security must be managed by the DoD and not the software developer.

Physical security schemes and operating procedures will also have an impact on the software architecture. For example, many communication security (COMSEC) devices need only routine security until the keys, usually software programs, are applied; then, much more stringent security procedures are implemented. Knowledge of this security feature would be



a key requirement of the developer; he/she must understand how and when the critical software pieces are uploaded to the COMSEC device. The same holds true for weapon systems that upload sensitive mission data just prior to launch.

Residual software on equipment or munitions that could fall into enemy hands presents another type of security challenge that needs to be addressed during the application development. For example, the ATACMS missile air-delivers some of its warheads, leaving the missile body to freefall to the surface. It is very conceivable that the body could be intact and, of course, unsecured. If critical mission software was still within the body and found by enemy forces, valuable information may be gleaned from knowing how the system finds its targets. We would certainly want the developer to design the applications in a way that would make anything recovered useless to the enemy, but this is a capability that is not intuitive to the software developers.

Network Development

The network is a lynchpin for the combat effectiveness of NCW architecture, and as such, should be developed under a professional Program Management (PM) organization. The US Navy has achieved optimal results by assigning a PM for the Link 16 Program as noted by SEI: “The Navy created a PMO and funded it with money from affected programs. These monies were returned to programs specifically to work toward Link 16 capability” (Morris et al., 2004, p. 33). SEI goes on to describe the need for professional program management by stating, “What is needed are processes that help to reach agreements, blinders that avoid getting distracted by things that are not related (e.g., portability), and to be agnostic about specific technologies (e.g., CORBA or Message Oriented Middleware)” (p. 34). A network PM would help facilitate and broker those agreements to the benefit of the network, vastly increasing the probability that the NCW asset will provide the warfighter the capability and advantage visualized by DoD.

Summary

To get the needed Open Architecture performance the DoD is seeking for software components, the Material developer will have to specify it in the RFP and Performance Specification. Unlike many hardware-centric engineering environments, the immature software engineering environment is unlikely to compensate for essential performance that is not specified. With the Materiel Developer performing the capabilities analysis using the MUIRSS approach outlined above, the potential software developers will be provided a much more detailed understanding of critical capabilities the DoD expects from its software components.

This same technique should result in significantly more accurate proposals as much more of the software development work can be estimated from the RFP and Performance Specification provided. Yes, proposals will likely continue to be overly optimistic, especially in a competitive environment. And yes, changes and details will still be revealed after the contract is signed—but the cost growth should be in the range of ten percent of the cost, not the current average of one-hundred percent of the original proposal. Schedule estimates will also be much more accurate as the scope of the software work is better understood by the contractors, keeping schedule slippage to under fifteen percent of the original proposal estimate.



Conducting this analysis will be as challenging as it is time-consuming, especially since it is applied in the early stages of the acquisition process when there is great pressure to “get the RFP on the street.” The enormous potential time and cost savings realized throughout the remaining development and the system’s lifecycle by completing the thorough MUIRSS capability analysis warrants the needed analysis time. There is an old carpenter’s adage that applies well in this case: “measure twice, cut once.”

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Acoustic Rapid COTS Insertion—Case Study

Presenter: Michael W. Boudreau, Colonel, US Army (Ret), has been a senior lecturer at the Naval Postgraduate School since 1995. While an active-duty Army Officer, he was the Project Manager, Family of Medium Tactical Vehicles, 1992-1995. He commanded the Materiel Support Center, Korea, 1989-1991, and the Detroit Arsenal Tank Plant, 1982-1984. COL Boudreau is a graduate of the Industrial College of the Armed Forces; Defense Systems Management College; Army Command and General Staff College; Long Armour-Infantry Course, Royal Armoured Corps Centre, United Kingdom; and Ordnance Officer Basic and Advanced courses. He holds Bachelor of Mechanical Engineering and Master of Business Administration degrees from Santa Clara University, California.

Executive Summary

In the mid-1990s, the submarine community recognized the impending loss of US technical superiority in submarine acoustics when foreign submarines began to exhibit major reduction in noise signature. This resulted in a critical need to improve acoustic sensing systems to better recognize foreign submarines. Although new capability was critically needed, required resources were not available to support the developmental effort. Critical need and the absence of sufficient funding constituted a *crisis*—demanding a revolutionary approach to achieve necessary technological improvement.

The approach came to be called A-RCI—Acoustic Rapid COTS Insertion, which might be characterized in the following manner. A-RCI used modular open-system architecture (MOSA). Hardware and software would progress on different paths and timelines. Key interfaces, standards, and protocols would be rigorously controlled as necessary to insure that different modules would work together. Commercial Off-the-shelf (COTS) purchases would be encouraged, and software reuse would be accomplished where feasible. Innovative solutions would be sought from a deliberately broadened array of participants, including defense contractors, Government labs, academia, and small business. Technical performance would be demonstrated by testing against known real-world performance standards. Technical decisions would be validated by peer review.

The A-RCI approach demanded a new way of doing business. Technical approaches must compete on a level playing field. Contractual mechanisms must be established to address not only competition, but also cooperation among winning competitors once the selections were made. Intellectual property rights and sharing of information must be carefully structured to achieve fairness as well as practicality. Rapid improvement must be brought to fielding via demanding schedules. The Navy's relationship with the prime contractor must change dramatically. The submarine user community must be intimately involved.

A-RCI took an integrated acoustic system that was difficult and time consuming to change and converted it into a federated system that could be upgraded in modules—"Plug and Play." Such an approach was common in the private sector in the 1990s and even before. Although the idea wasn't new, the application of this approach to a warfighting system was daunting. As a point of reference, in the mid-1990s, IBM was struggling with the similar arguments about changing the way they did business; that is, should IBM stick with mainframe computers running proprietary programs, or should the company pursue the



integration of “best of breed” software solutions that could interoperate with competitors’ software and run on computers manufactured by competitors of IBM? Even today, there are arguments within DoD about whether federated systems are a sound approach.

Acoustic Rapids COTS Insertion progressed at a seemingly crushing pace, with software changes being implemented annually and hardware changes biannually. A-RCI was a “poster child” for evolutionary acquisition, because the endpoint of the effort was not clearly defined, even though there was a recognized need for improvement.

The results of A-RCI were astounding cost reduction, dramatic improvement in technical performance, successful use of COTS hardware in a critical warfighting application, logistics support improvements, and an acquisition model that might have broad applicability across the DoD.

Together with A-RCI’s amazing results came a series of questions that must be considered. Was A-RCI a one-time success, providing a model that could not be re-applied because of structural impediments within DoD? Was A-RCI leadership a unique alignment of extraordinary people that brought about change, but is unlikely to be duplicated for future systems? Is DoD’s acquisition culture so rigid that it will stifle and kill future similar efforts? Will cooperation among the user community support similar efforts in the future? Are there such operational demands on the user community that members cannot tolerate the tempo of change that delivers new software or hardware technology annually or bi-annually? Is modular open-systems architecture scaleable to large warfighting systems: fire control or command and control systems, for example?

This research will result in publication of a case study in late summer 2006.



Panel – Budgeting for Defense Acquisition Requirements

Wednesday, May 17, 2006	Budgeting for Defense Acquisition Requirements
3:15 p.m. – 4:45 p.m.	<p>Chair:</p> <p>RADM James Greene, USN (ret.) – Naval Postgraduate School</p> <p>Discussant:</p> <p>VADM Tom Hughes, USN (ret.) – Naval Postgraduate School</p> <p>Papers:</p> <p><i>Reform of Budgeting for Acquisition: Lessons from Private Sector Capital Budgeting for the Department of Defense</i></p> <p>Jerry McCaffery, Naval Postgraduate School</p> <p>Larry Jones, Naval Postgraduate School</p> <p><i>Budgeting for Capabilities Based Planning</i></p> <p>Lt Col Steve Fraser, US Air Force Academy</p> <p>Kurt A. Heppard, Associate Professor of Management, United States Air Force Academy</p> <p>Steve G. Green, Professor of Management, United States Air Force Academy</p> <p>Brian C. Payne, Captain, Instructor of Management, United States Air Force Academy</p>



Reform of Budgeting for Acquisition: Lessons from Private Sector Capital Budgeting for the Department of Defense

Presenter: Jerry McCaffery, PhD, serves as Admiral George F. A. Wagner Professor of Public Management in the Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA. Professor Jones teaches and conducts research on a variety of government financial and management reform issues. He has authored more than one hundred journal articles and book chapters on topics including national defense budgeting and policy, management and budget control, public financial management, and international government reform. Dr. Jones has published fifteen books including *Mission Financing to Realign National Defense* (1992), *Reinventing the Pentagon* (1994), *Public Management: Institutional Renewal for the 21st Century* (1999), *Budgeting and Financial Management in the Federal Government* (2001), *Strategy for Public Management Reform* (2004), and *Budgeting and Financial Management for National Defense* (2004).

Larry Jones, is a Professor of Public Budgeting in the Graduate School of Business and Public Policy at the Naval Postgraduate School where he teaches courses focused on defense budgeting and financial management. He has taught at Indiana University and the University of Georgia. His current research interests include defense transformation and the PPBE system and their impact on DoD acquisition and resource allocation. He and Professor Jones are the authors of *Budgeting and Financial Management for National Defense* (2004).

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INTRODUCTION

The ongoing replacement of Department of Defense (DoD) capital assets, as well as other much needed capital investments, will likely take place during a time of decreasing, or at least slowly growing financial resources over the long term. Some of this is due to the growth of entitlements, some to the size of the predicted deficit. Still another pressure is the long-term cost of military activity in Afghanistan and Iraq, predicted by CBO to be \$450 billion over the next ten years. In addition, the Department of Defense is in the midst of an era of “transformation” under Secretary of Defense (SECDEF) Donald Rumsfeld that calls for the modernization of DoD warfighting doctrine, capital goods and business systems. The budgeting system has already been modified during Rumsfeld’s tenure (McCaffery & Jones, 2004, p. 403-435). Occasionally, it has been argued that the federal government and other public agencies should adopt “corporate” methods of budgeting to include the use of separate capital and operating budgets that are prevalent in the private sector. In the past, this argument has not made much progress, but the current trends enumerated above move us to consider that this argument should be revisited. It is clear that significant changes would have to occur in the present system if private budgeting methods were adopted by the DoD and other public organizations, but there are examples of public organizations that

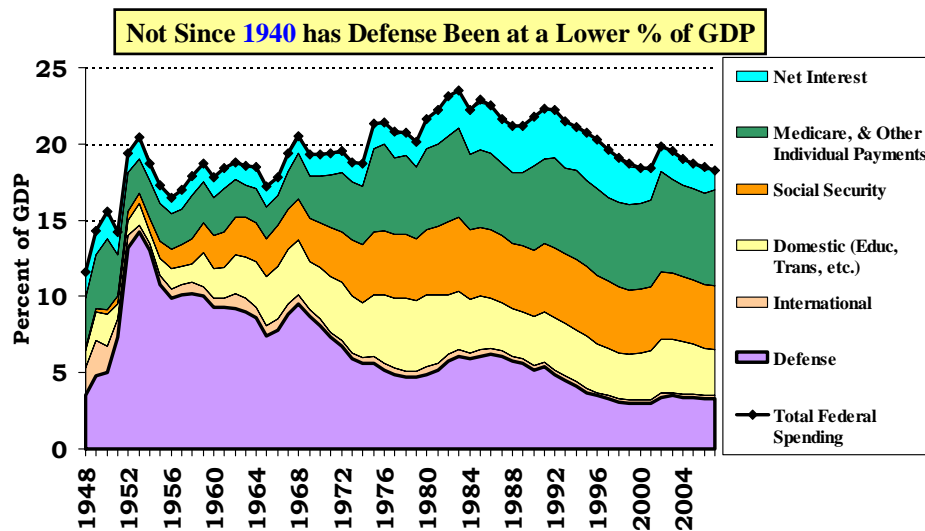


have made this leap, as the governments of New Zealand and Australia, as well as most of the states in the US have at least adopted some private budgeting methods with varying degrees of success.

History Indicates Change Necessary

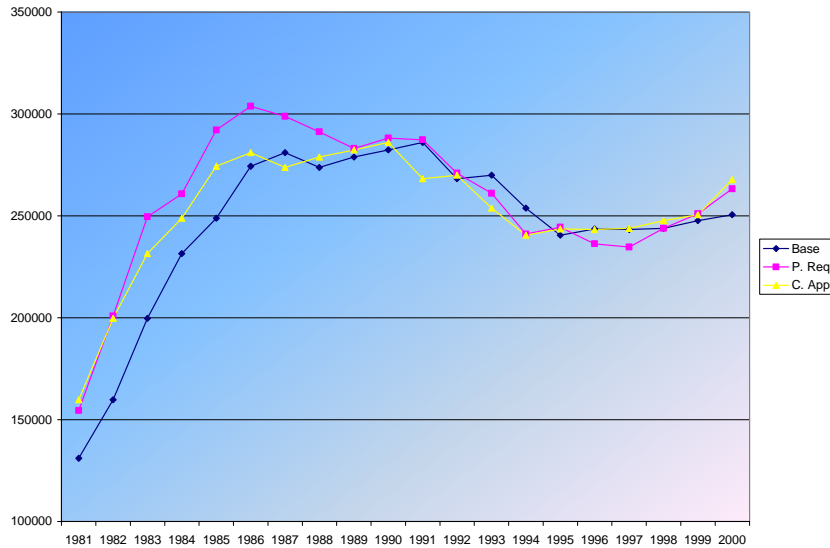
From a historical dimension, Defense appears to be a declining share of the federal budget, set amongst a set of steadily growing accounts. From a historical perspective, DoD spending looks like it follows relatively smooth, if declining, path.

Figure 1. Federal Spending as a % of GDP



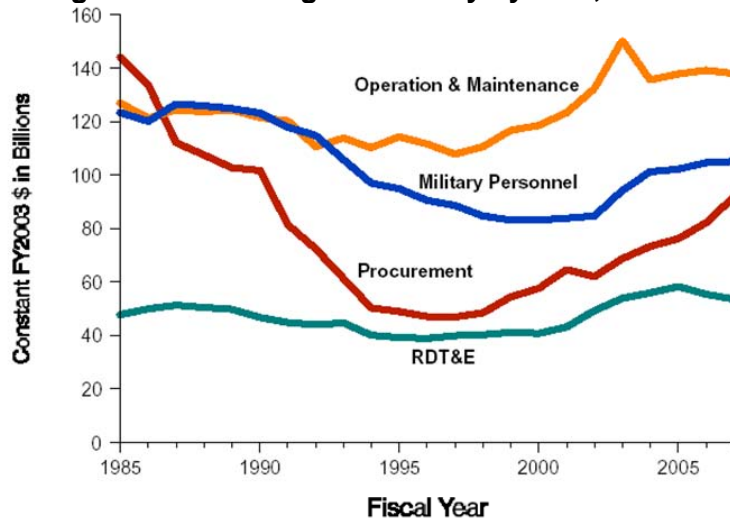
Over the last 20 years, the Defense line again looks relatively smooth, although some turbulence appears. The Reagan buildup is apparent, as is some difference in support for Defense between the President and Congress.

Figure 2. Defense Budget, 1981-2000



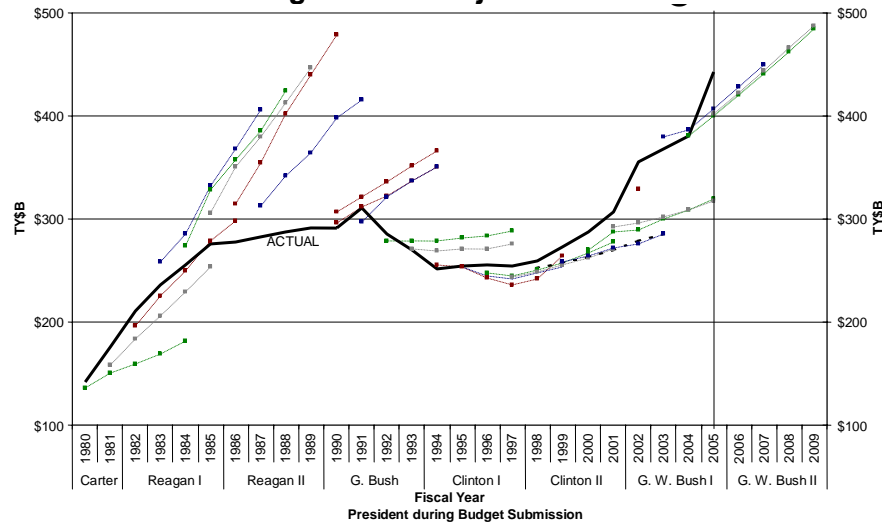
A study of accounts within the DoD indicates that this picture is not as smooth as it seems. The peace dividend at the end of the Cold War is apparent. It is also clear that the procurement account is the most volatile.

Figure 3. DoD Budget Authority by Title, FY1985-2007



When the FYDP is overlaid on the DoD budget, it is clear that the future rarely unrolls as expected. Over twenty years, only the 1982 FYDP unrolled about as expected. Reality moved away from the other years as often as the second year of the FYDP. This gives rise to the adage, "Everyone gets well in the outyears... But the outyears never arrive."

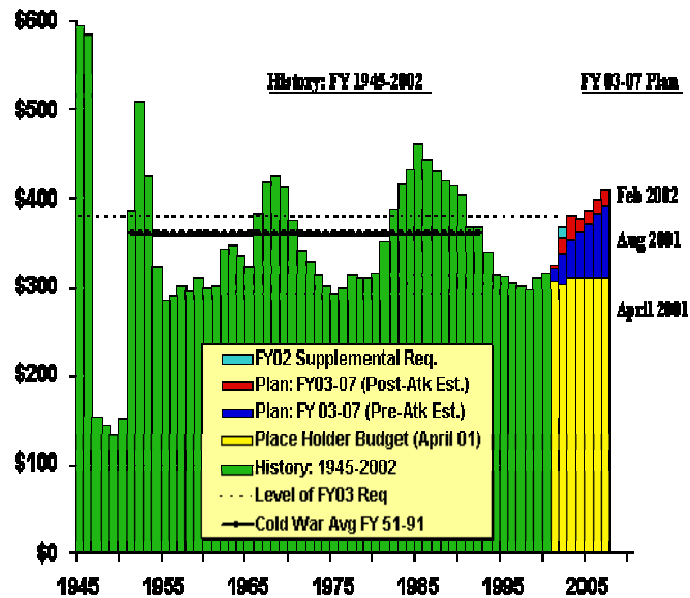
Figure 4. President's Budget FYDP Projections vs. Actual Defense Budget



This picture of volatility and unpredictability has long historical roots.

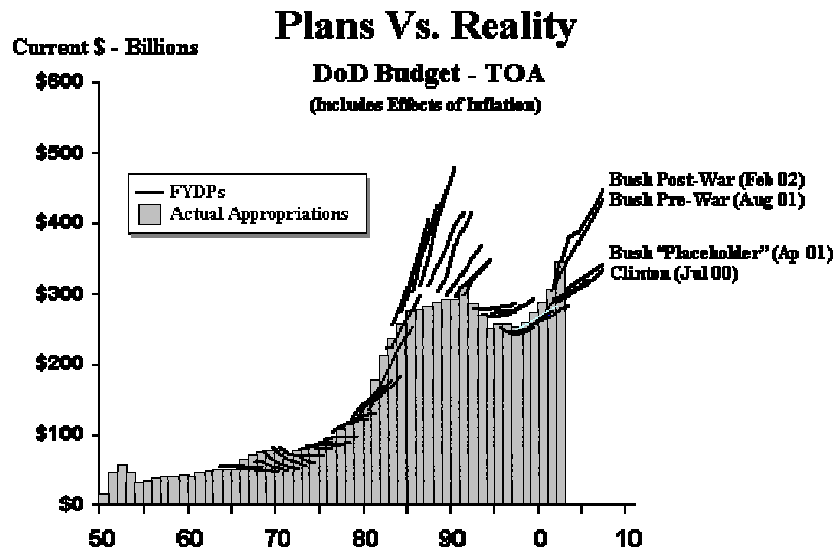
Figure 5. Evolution of the FY2003-2007 Plan in a Historical Perspective

DoD Budget Authority (FY2003 Const \$ - Billions)



In fact, the disagreement between the FYDP and reality may be traced back to the 1960's.

Figure 6. DoD Budget - TOA



It is not unexpected then, that as plans change, so do budgets; this includes budgets for the procurement accounts and weapons system acquisition patterns. For example, the Raptor program shows increasing expense and decreasing numbers over its 20-year lifecycle.

Figure 7. The Raptor Program

The current DoD resource allocation system is PPBE, a system that includes capital and operational budgeting through the DAS-JCIDS-PPBE process.

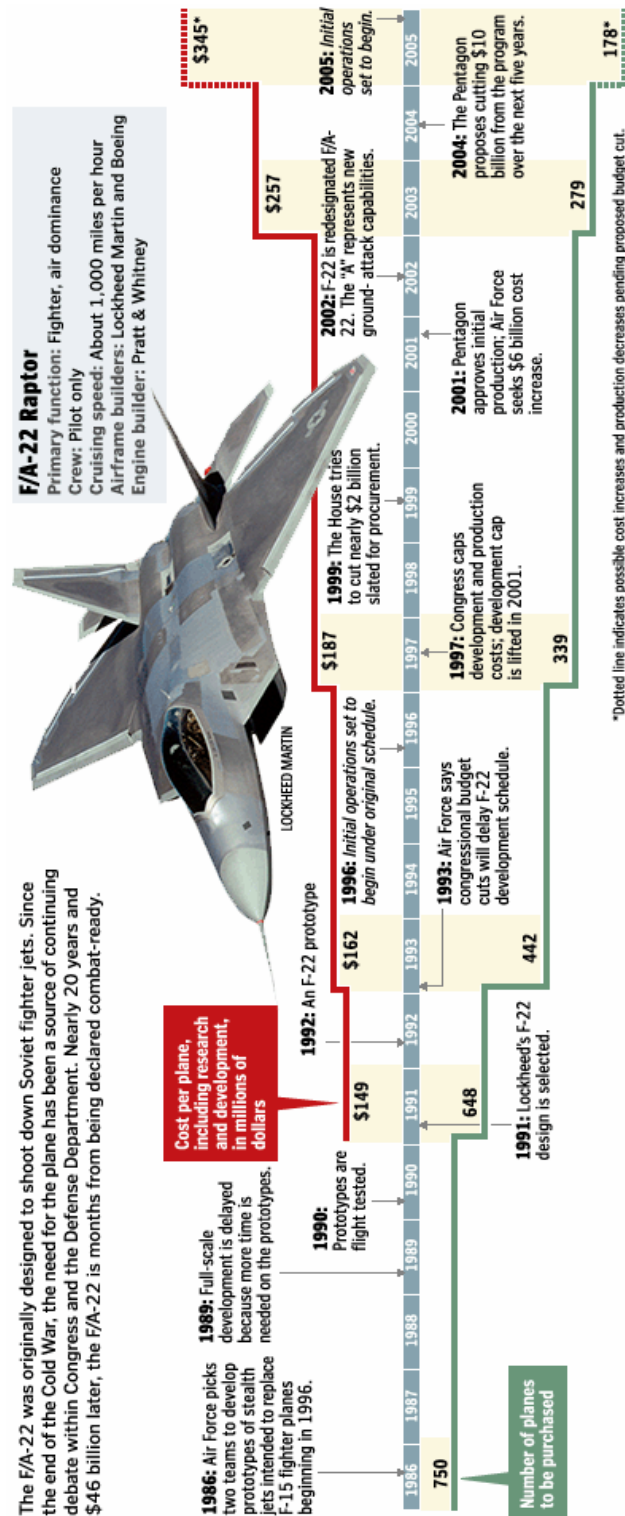
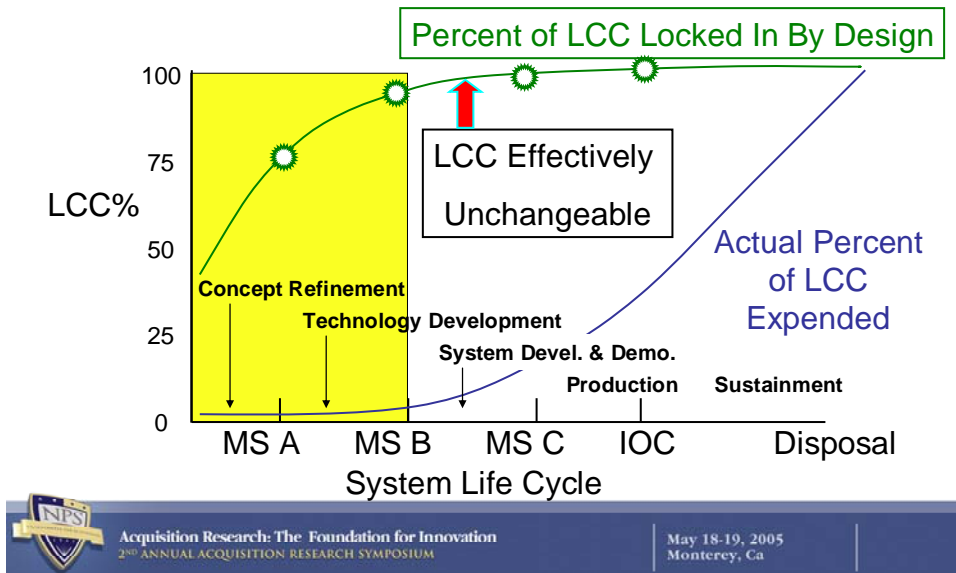


Figure 10. Early Decisions Set the Course for Total Ownership Costs (Boudreau, 2005)



We suggest that perhaps it would be wise to separate capital and operating budgets for the DoD. The current system is operable, but its overhead and administrative costs are high, top-level people have to pay constant attention to it, and weapons systems are always in danger of being delivered late or over-budget and under requirements. In fact, DoD has already recognized this and begun the movement.

QDR Recommends Capital Budget

The 2006 Quadrennial Defense Review has recommended that DoD establish a capital account for major acquisition programs. This recommendation mirrors the outcome of the Defense Acquisition Performance Assessment study directed by Deputy Secretary of Defense Gordon England. In its findings in December, 2005, this study recommended:

The Secretary of Defense should establish a separate Acquisition Stabilization account to mitigate the tendency to stretch programs due to shortfalls in the Department of Defense non-acquisition accounts that ultimately increases the total cost of programs. This will substantially reduce the incidence of "breaking" programs to solve budget year shortfalls and significantly enhance program funding stability. (Defense Acquisition Performance Assessment, 2005, p. 10).

In effect, the panel recognized that acquisition account leaders could not protect the acquisition accounts from acting as a bank for the operating accounts during budget execution—thus the recommendation that DoD's procurement, research and development budget be separated from the overall defense budget. This separation:

would help prevent the kind of financial whiplash that causes cost overruns, said retired Air Force Lt. Gen. Ronald Kadish, panel director and a vice president at Booz Allen Hamilton, a government consulting firm in Fairfax, Va. The panel found that every dollar taken from a program induces \$4 of cost increases in later years...

Though many in Washington blame the uncertainty on Congress, Kadish said most of the damage was self-inflicted by the Pentagon. (Ratnam, 2005).

In its work comparing best practices in industry and DoD acquisition programs, the GAO sent out surveys to 185 Category I and II DoD programs managers in April, 2005 (GAO, 2005, November—The response rate was 69%. See page 19-20 for a discussion of methodology.). Their responses illustrate some of this turbulence. Results from this study indicate that the problem is not only the non-acquisition accounts robbing the acquisition accounts, but also that the DoD has flaws in what could be called its capital budget process: it starts too many programs and fails to prioritize programs in process so that resources may be shifted to the most appropriate program when necessary in a distressed fiscal environment (e.g., when costs of raw materials or labor rise). The GAO says:

The primary problem, according to many program managers and verified by GAO's work, is that DoD starts more programs than it can afford and does not prioritize programs for funding. This creates an environment where programs must continually compete for funding. Before programs are even started, advocates are incentivized to underestimate both cost and schedule and overpromise capability. (GAO, 2005, November, pp. 8-9)

Program manager comments tend to blame OSD for part of the problem, as well as funding instability.

Figure 11. Highlights of Program Manager Comments Regarding Competition for Funding (GAO, 2005, November, p. 40)

- OSD staff has reduced funding without any understanding or appreciation for program impacts. It appears that the staff makes arbitrary cuts.
- OSD has a very near-term execution year focus, resulting in great instability. In reality, it should provide much more strategic vectors for the Department instead of short-term adjustments to fix more tactical-level funding needs.
- My experience is that the [service] and OSD typically cut programs to pay top down bills.
- There is no such thing as funding stability in DOD. Funding reductions and program stretchouts are the norm due to top down fiscal bills that occur during the execution year. The Pentagon must pay the bills, therefore it takes funds from the programs, thereby contributing to program stretchout, cost increases, inefficiencies, etc.
- Unstable funding results in pressure to do aggressive things in order to minimize the impact of budget cuts on schedule and performance. I believe this has been a major factor in recent...program execution problems.
- Our product is considered a support function. When funding gets tight, we have been considered a bill payer for others, even if it has "broken" our program.

Sources: GAO survey.

As Figure 11 intimates, program managers believed that they were operating in an environment where there was unfair competition for funding (GAO, 2005, November, p. 40). The results were all too predictable. The next two figures indicate some of the dimensions of the problem. First, in Figure 12, most program managers believed that the parameters of their program were reasonable at the start, with about 24% falling in the some (18%) or little or no (6%) categories.



Figure 12. To What Extent Were the Parameters of Your Program Reasonable at Program Start? (GAO, 2005, November, p. 43)

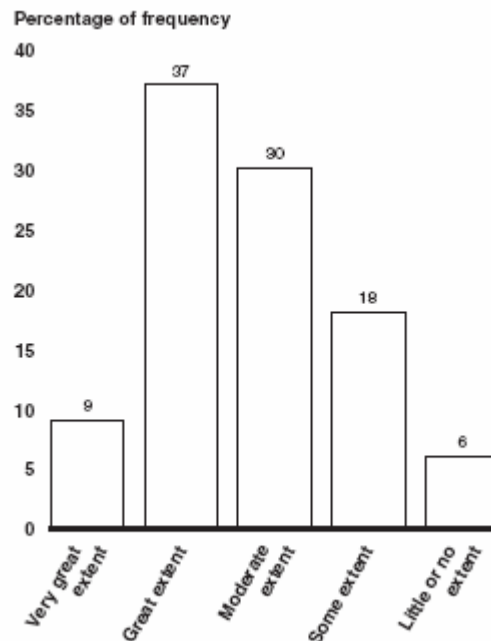
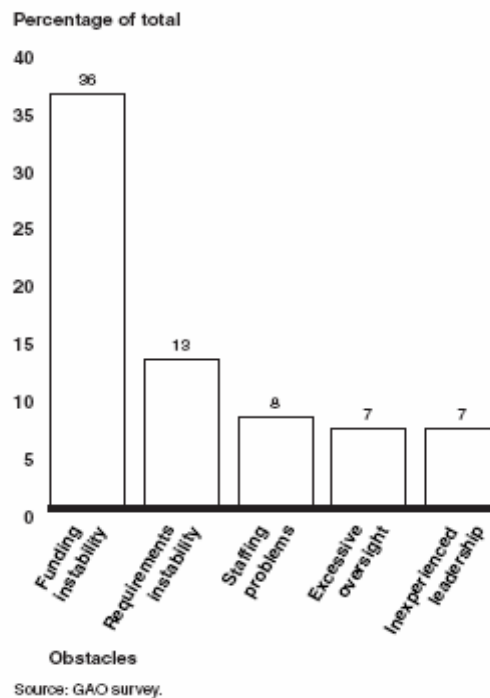


Figure 13. How Program Managers Responded to an Open-ended Question on What Were the Biggest Obstacles They Faced (GAO, 2005, November, p. 44)



In response to an open-ended question on biggest obstacles, 36% of the managers responded that funding instability was the biggest obstacle, almost three times the number who mentioned requirements instability, the next category. What these evidences seem to hint is that much of the cause of acquisition turbulence lies in the funding mechanism.

In Secretary England's confirmation hearings, both the Senate and House Armed Services Committees expressed an interest in improving acquisition practices, an interest that was specified in the reports on the DoD authorization bill. For example, the Senate report accompanying S1042, the Senate version of the Defense Authorization bill, notes that after nearly twenty years of reform since the Packard Commission Report and Goldwater-Nichols, "major weapons systems still cost too much and take too long to field." The committee added, "Funding and requirements instability continue to drive up costs and delay the eventual fielding of new systems. Constant changes in funding and requirements lead to continuous changes in acquisition approaches" (Senate Report, 2005, May 17, p. 345—see also House Conference Report, 2005, May 20, pp. 354-356).

The end of this thread lies in the recommendations and findings made in the *QDR* in language that went beyond the establishment of a capital account, to include a capital budgeting process:

Fourth, to manage the budget allocation process with accountability, an acquisition reform study initiated by the Deputy Secretary of Defense recommended the Department work with the Congress to establish "Capita Accounts" for Major Acquisition Programs. The purpose of capital budgeting is to provide stability in the budgeting system and to establish accountability for acquisition programs throughout the hierarchy of program responsibility from the program manager, through the Service Acquisition Executive, the Secretaries of the Military Departments and the Office of the Secretary of Defense. Together, these improvements should enable senior leaders to implement a risk-informed investment strategy reflecting joint warfighting priorities. (Quadrennial Defense Review, 2006, February, pp. 67-68)

This process would be supported by a procedure that would rest on joint collaboration among the warfighter, acquisition and resource communities, with the warfighters assessing needs and time-frame and the acquisition community contributing technological judgments on technological feasibility and "cost-per-increment" of capability improvement. The budget community's contribution would be an assessment of affordability. These inputs would be provided early in the process, before significant amounts of resources are committed. The *QDR* also recommended that the DoD, "begin to break out its budget according to joint capability areas. Using such a joint capability view—in place of a Military Department or traditional budget category display—should improve the Department's understanding of the balancing of strategic risks and required capability trade-offs associated with particular decisions" (Quadrennial Defense Review, 2006, February, pp. 67-68). The DoD promised to explore this approach later with Congress. History indicates that Congress clings tenaciously to the appropriation structure currently in place because it serves Congress's purposes, but it is good to remember that all that is now familiar was once new.

In the figure below from the GAO work on Best Practices (2005, p. 59), program managers reported on what types of authority they thought they needed. The implications are clear: program managers believe they need more authority to execute their programs and efficiently allocate the resources they have been given, without undue and unnecessary



oversight, without needlessly complicated reporting requirements. The GAO found that program managers expressed frustration with the time required of them to answer queries of oversight officials, “many of which did not add value. Some program managers, in fact, estimated that they spent more than 50 percent of their time producing and tailoring and explaining status information to others”(GAO, 2005, November, p. 46). The GAO also noted, “program managers commented that requirements continue to be added as the program progresses and funding instability continues throughout. These two factors alone cause the greatest disruption to programs, according to program managers (GAO, 2005, November, p. 45).

Perusal of the comments below indicate that a capital account process will cure some of the problems program managers reported, but not all, without dramatically changing reporting arrangements in the military departments.

Figure 14. Highlights of Program Manager Comments on What Types of Authority They Need (GAO, 2005, November)

- Program managers need to have more ability to control their funding in order to make more efficient system and production trade-offs. Program managers also need more ability to work with the warfighter to pursue moderate or even high risk strategies when the payoff for the warfighter warrants such a change. Program managers also need the ability to directly interface with OSD and with Congress and should not be restricted through service staffs in order to facilitate communications.
- Program managers should be able to select and award most contracts versus going to the PEO or service acquisition executive for a decision.
- I believe program managers should be allowed to spend small amounts of underrun as they see fit for their program. Too often, any underrun is taken to pay for other programs.
- [We need] more authority to budget for and manage management reserves. The [planning and budgeting] process is too slow to react to new funding requirements to mitigate program risks.
- In the current environment, we do not control the numbers of military, civilian, or contractor personnel that work in the program office. We do not have the authority to hire and fire personnel, or to seat personnel in our office space. We do not have the authority to get adequate tools for our people to do their work, such as computers, printers, copiers, telephones, etc.
- Once appropriated by Congress, program managers should have more flexibility to transfer between program elements and budget accounts, and also the service and major commands should have less ability to remove funds that are being properly executed in order to transfer them to other programs.
- Program managers should be given authority to move funds between colors of money. Colors of money greatly reduce the flexibility that program managers often need to make tradeoffs within their programs.
- [We need authority] to be able to fire or replace people immediately or affect their bonus.
- [We need authority] to give monetary awards to support professionals.
- The key is not more authority; it is allowing program managers to fully exercise the authority they already have. No program manager minds reasonable oversight, but the current level of oversight is unreasonable.

Source: GAO survey.

In the next section, we assess the state of capital budgeting in the DoD and the private sector.



CAPITAL BUDGETING IN THE DoD AND THE PRIVATE SECTOR

A. DoD CAPITAL BUDGETING PRINCIPLES AND METHODS

The process of budgeting for capital assets in the Department of Defense (DoD) is a complex process with many moving parts. While DoD employs some of the same techniques for evaluating capital projects as organizations in the private sector do, such as cost-benefit analyses, it does not have a separate capital budget and must take many other factors into account when designing its plan for capital spending. The process of budgeting for capital assets in the DoD, as well as other federal agencies and departments, is governed by rules set forth by the Office of Management and Budget (OMB), laws passed by Congress, and the Federal Management Regulations (FMR). Additionally, DoD proposals for new capital projects “must be supported by elaborate analytical justifications and reviewed and approved by hundreds of people all along the line from the lowest to the highest echelon” (Jones & Thompson, 1999).

1. Definition of Capital Assets

Capital assets, as defined by OMB, are “land, structures, equipment, intellectual property, and information systems that are used by the Federal Government that have a useful life of two years or more” (OMB, 2003).

2. Principles of Budgeting for Capital Assets

Before any capital spending is included in the President’s Budget, the DoD must satisfy the principles of planning, costs and benefits, financing, and risk management requirements as set forth by OMB.

a. Planning

When planning for investments in capital assets, the DoD must ensure that the following criteria are met:

- The asset must support the core missions of the DoD.
- No other private or public agency can support the function more efficiently than the DoD.
- The asset should support work processes that reduce costs, improve effectiveness, and make maximum use of commercial, off-the-shelf technology.
- The asset must demonstrate a return-on-investment superior to any other alternative. Returns can include improved mission performance, reduced cost, and increased quality, speed, or flexibility.
- The asset must reduce risk. This basically means that fully tested pilots or prototypes are pursued before proceeding with full funding for the end item.
- If the investment is planned for more than one asset (i.e., 100 Joint Strike Fighters), then it must be implemented in phases as narrow in scope as practicable, with each phase delivering a measurable net benefit independent of future phases.



- The asset should employ an acquisition strategy that allocates the risk efficiently between the Government and the contractor, uses competition, ties contract payments to performance, and takes advantage of commercial technology (OMB Circular A-11, Appendix J).

OMB uses this information to determine the feasibility of the investment, set the basis for full-funding, and for deciding whether the capital purchase has been justified well enough to be included in the budget (OMB, 2003).

b. Costs and Benefits

In addition to meeting the above criteria, DoD justification for the purchase of any particular capital asset must include a cost-benefit analysis. The asset's total lifecycle costs must be compared to the benefits that it is expected to provide. However, as is the case for many of DoD capital asset proposals, the benefits of the asset may be hard to define in monetary terms, which is why the focus is generally placed on lifecycle costs. Additionally, when comparing different capital projects, it may be determined that each asset provides essentially the same benefit. For example, if DoD is evaluating two competing designs (i.e., from two different contractors) for a new weapons system, even though the design may be different, the benefit provided by each one may essentially be the same. In these instances, DoD can conduct a cost-effectiveness analysis of the competing programs/assets (OMB, 1992). The standard used in conducting cost-benefit analysis is net present value. This process involves assigning monetary values to the benefits and costs of the asset, discounting these values using an appropriate discount rate (set by OMB), and subtracting the sum of discounted costs from the sum of discounted benefits. Capital investments with a positive net present value are preferred to those with a negative net present value.

DoD may also conduct a cost-effectiveness analysis when justifying a capital asset proposal. As stated in OMB Circular A-94, "A program is cost-effective if, on the basis of lifecycle cost analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits." This type of analysis is used when benefits either can not be monetized or it is not practical to monetize the benefits. As noted previously, this is often the case for DoD weapons systems. However, when benefits can not be monetized, OMB encourages DoD to supplement cost-effectiveness analyses with information that quantifies the benefits in physical measurements or effectiveness measures (OMB, 1992). For example, DoD may quantify the benefits of a new aircraft in terms of increased readiness percentages, capability to deliver more ordnance than current aircraft, or lower maintenance costs.

c. Financing

OMB has established principles of financing that DoD must consider when proposing spending for capital assets. The principles include the following: (1) full funding, (2) regular and advanced appropriations, and (3) separate funding of planning segments (OMB, 2003).

Full funding refers to the Budget Authority (BA) required to complete a "useful segment" of a capital investment. Congress must appropriate the BA before DoD can incur obligations for the capital asset. A "useful segment" is, "a unit of a capital project that can be economically or programmatically useful even if the entire project is not completed" (GAO, 1998). Full funding ensures that all costs and benefits are taken into account at the same time that decisions are made by Congress to provide or not provide BA for a capital



investment. Full funding also helps to ensure lower acquisition costs, prevent cancellation of projects, and ensure that enough funding is provided to maintain and operate the assets (OMB, 2003).

Full funding by regular appropriation in the budget year is recommended by Congress and the GAO because it allows decision makers to make tradeoffs between competing capital projects as well as other spending purposes. However, this may result in “spikes” in the budget that are not good for the DoD or Congress. Given the large dollar amounts required for many DoD capital asset acquisitions, this situation often presents itself. In situations like this, a combination of a regular appropriation in the budget year and some advance appropriations in subsequent years may be necessary to fully fund a capital project (OMB, 2003).

Planning for a capital asset should be funded separately from the actual purchase of the asset. The DoD needs information in order to plan, develop designs, compute costs and benefits, and assess risk levels for capital projects. Most of this information comes from the Research, Development, Test, and Evaluation (RDT&E) process. Separate funding for RDT&E and procurement helps to ensure that costs, schedules, and performance goals are known prior to proceeding to actual procurement of the assets (OMB, 2003).

d. Risk Management Requirements

Risk management is an important aspect in the process of budgeting for capital assets. The DoD must conduct a thorough risk analysis for each capital asset acquisition in order to minimize cost overruns, schedule problems, and assets that fail to perform as expected. Risk analyses should define how risks will be minimized, monitored, and controlled. Finally, the DoD must, “ensure that the necessary acquisition strategies are implemented to reduce the risk of cost escalation and the risk of failure to achieve schedule and performance goals” (OMB, 2003).

3. Planning Phase of the Capital Programming Process

Detailed and comprehensive planning is even more necessary when trying to manage limited budgetary assets, which is the situation with most federal agencies, including the Department of Defense. Budgeting and planning, therefore, must be linked together in order for success. “There can be no good budget without a plan, and there can be no executable plan without a budget to fund it” (Capital Programming Guide, 1997).

The planning phase is the nucleus of the capital budgeting process used in most federal agencies. Decisions yielded by the planning phase are applied throughout the budgeting and other phases, and information from the other phases feeds back into the planning phase. The six steps in the planning phase are 1) strategic and program performance linkage, 2) baseline assessment and identifying the performance gap, 3) functional requirements, 4) alternatives to capital assets, 5) choosing the best capital asset, which focuses on benefit/cost and risk analysis, and 6) the agency capital plan, which is to include an inventory of existing capital assets (*President’s Conference Staff Budget Staff Paper*, 1998). Each of these steps will be discussed in greater detail below.



a. **Strategic and Program Performance Linkage**

The Government Planning and Results Act (GPRA) established the legal requirements for federal agencies to develop strategic plans and link these plans to requests for budgetary resources. The capital programming process (a.k.a. capital budgeting) is an important piece of any agency's strategic planning process. Quality strategic plans should detail the agency's needs for particular capabilities, identify the capital assets that are needed to accomplish the goals of the agency's plan, and delineate the results that these capital assets will produce. The agency's strategic plan also needs to take into account the estimated budgetary resources that will be available and define goals and objectives for each major program based on the agency's mission (Capital Programming Guide, 1997).

In 1996, the Government Accountability Office (GAO) produced a study that described three practices that are extremely important for strategic planning to have the desired impact. The three practices are as follows:

- Involve all the pertinent stakeholders to include Congress, the Administration, customers, service providers, employees, and interest groups.
- Take an assessment of the agency's internal and external environments in an effort to anticipate future difficulties so that appropriate adjustments can be made.
- Align the agency's activities, processes, and resources to support results that are in line with the mission.

These practices are similar to the Strengths, Weaknesses, Opportunities and Threats (SWOT) analyses that private corporations use in their strategic planning processes.

Agency strategic plans should produce goals and objectives for its programs. These goals and objectives, embodied in an agency annual performance plan, should detail how outputs will be achieved and describe the role that particular capital assets will play in achieving the desired outcomes. This information essentially defines "how much bang we are getting for the public's buck" (OMB, 1997). The better an agency is able to link a capital asset to a strategic, mission-related outcome, the more likely it will be able to justify the resource request associated with that capital asset.

b. **Baseline Assessment and Identifying the Performance Gap**

The Office of Management and Budget has established that federal agencies should conduct planning through Integrated Project Teams (IPT) that brings together several disciplines to evaluate the capabilities of existing capital assets. This evaluation will help provide information needed for identifying performance gaps between current and planned results. Additionally, the assessment of current assets should include information concerning functionality, lifecycle costs and the affordability of lifecycle costs, risk, and the agency's ability to manage risk. This information for every agency program enables the agency to examine their entire collection of capital assets when trying to define alternatives to fill performance gaps.



c. Functional Requirements

If it is determined that an agency's current capital assets cannot bridge the performance gaps, the gaps need to be defined in terms of additional performance requirements that need to be met. The agency must take care not to define these requirements in terms of specific equipment, but rather in terms of mission requirements, capabilities needed, cost objectives, and constraints. As these functional requirements are being generated, the capabilities of other assets and/or processes must be considered. For example, it may be determined that a new, technologically advanced capital asset is needed to meet a program's goal. However, if the other assets that support this "new" asset have obsolete technology which will not "work" with the new asset, simply buying the new asset may not enable that program to meet the desired requirements.

d. Alternatives to Capital Assets

Once the requirements have been defined, the agency must now determine whether a new capital asset is needed to meet the requirement. In general, given the expense involved with the purchase of many capital assets, agencies should spend considerable effort to determine if there may be procedural or process improvement actions that can be taken to meet the defined requirement. The Office of Management and Budget has suggested that federal agencies should answer the following questions prior to making the decision to purchase new capital assets:

1. Does the investment in a major capital asset support core/priority mission functions that need to be performed by the Federal Government?
2. Does the investment need to be undertaken by the requesting agency because no alternative private sector or governmental source can better support the function?
3. Does the investment support work processes that have been simplified or otherwise redesigned to reduce costs, improve effectiveness, and make maximum use of commercial, off-the-shelf technology (COTS)?

Only if the answer to all of these questions is "yes," should the agency proceed with an acquisition of a new capital asset. Even if all questions are answered positively, the agency is still encouraged to consider all viable alternatives to meet the requirement including the use of human assets

e. Choosing the Best Capital Asset

The IPT needs information from management to determine if resources will be available for the purchase of new capital assets when the decision to purchase new capital assets has been made. Emphasis needs to be placed on innovative proposals from private industry contractors that make full use of competition between vendors. The IPT should also explore the use of commercial off-the-shelf technology and non-developmental items (NDI) in an effort to mitigate costs associated with purchasing a particular capital asset (OMB, 1997).

After a list of alternatives has been compiled, cost-benefit analyses need to be conducted, taking into account acquisition costs and numerous other lifecycle costs as well as the benefits that the asset will provide. Where possible, these benefits should be monetized and compared with the costs associated with the asset. The time value of money



should also be included in the analysis. Specific and detailed attention should be placed on obtaining realistic and credible estimates of lifecycle costs of the asset

Risk must be taken into account and planned for with every capital asset acquisition. Risk comes in numerous forms to include schedules' risk, cost risk, risk of project failure, and interdependency issues with other assets/programs. When developing a strategy to mitigate and manage risk, the IPT needs to consider all sources of risk and high risk should only be accepted when it can be justified by high expected returns from the asset (OMB, 1997).

The planning phase of the capital programming process must also include the development of plans for contract type, competition strategies, and management of capital assets during their lifecycle. The plans set forth in these areas are no less important than those discussed above and are critical to acquiring an asset that will truly meet the needs of the agency while delivering the required mission-related results (OMB, 1997).

f. The Agency Capital Plan

The final step in the planning process is the development of an agency capital plan. This capital plan should be part of the larger strategic plan for the agency and should detail the long-term decisions made with respect to the agency's capital asset portfolio. OMB currently encourages the federal agencies to develop these plans, but there is no "requirement" for agencies to have them.

The Agency Capital Plan is the most important output of the planning phase. However, the agency should not treat the plan as "set in stone" but rather a living document that can change as plans and priorities change over time. This document should serve as the agency's primary document for capital asset planning and can also be used to create budget justifications to Congress. This comprehensive plan should include, at a minimum, the following items:

- Statement of the agency's mission, strategic goals, and objectives
- Description of the planning phase
- Baseline assessments and identification of performance gaps
- Justification of spending requests for proposed new assets
- Staffing requirements
- Timing issues
- Plans for proposed capital assets once purchased and in use
- Summary of the risk management plans

Finally, the Agency Capital Plan should include a detailed description of how each asset in the agency's portfolio will enable the agency to achieve its outcome and output goals (that are defined in the strategic plan).



4. Budgeting Phase of Capital Programming Process

The budgeting phase of the capital programming process, which can also be called the “justification” or “approval” phase, formally begins when the agency, such as the Department of Defense, submits its request for capital asset acquisitions to the Office of Management and Budget. The OMB will then make its recommendation to the President for the construction of the President’s Budget. This phase ends when Congress appropriates funding and the OMB apportions funds to the DoD for the purchase of capital assets. If the decision is made not to fund the acquisition, it could return to the planning phase for submission the next year or the capital investment may be subject to further DoD review to determine if another investment better suits DoD strategic goals (Capital Programming Guide, Section II). The specific steps in the budgeting phase are briefly described below:

- **Step 1: Agency Submission for Funding:** In this step, the agency submits its budget, which includes the portfolio of capital assets approved by the agency head, such as Secretary of Defense (SECDEF) in the case of the DoD, to the OMB for approval. The submission should be in harmony with the principles of budgeting for capital assets detailed above. The OMB will then analyze the agency’s submission, often asking the agency to provide additional information, and make its recommendation to the President.
- **Step 2: Passback:** In this step, the agency is notified of OMB’s recommendation to the President. If the agency’s justification for the asset is not in compliance with the principles of budgeting for capital assets, they may have to make substantial changes to their initial request to include changes to funding levels, performance goals, and financing alternatives. The agency also has the option to appeal (reclama) OMB’s recommendation to the President.
- **Step 3: Agency Revision:** The agency may have to make adjustments to its proposal for capital spending due to changes that took place during the pass-back phase.
- **Step 4: Approved for the President’s Budget:** Once the agency’s proposal has made it through OMB scrutiny, it is now included in the President’s budget proposal to Congress.
- **Step 5: Congressional Approval/OMB Apportionment:** If Congress approves the proposal, it appropriates Budget Authority and the OMB apportions the BA to the DoD and the other federal agencies. After apportionment, Congress, the OMB, and other parties within the agency monitor the procurement process and implement corrective actions if necessary (OMB, 1997).

5. GAO Executive Guide: Leading Practices in Capital Decision-Making

In fiscal year 1997, the federal government spent \$72.2B on capital assets. Of this amount, \$52.4B, or roughly 73 percent, was spent for defense-related capital assets. Federal agencies, including the Department of Defense, are challenged with demands to improve performance in fiscally restrained environments. As a result, it is increasingly important for federal agencies to make effective capital acquisition choices, implement those choices well, and maintain the capital assets embodied in these choices over the long term.

The Government Accountability Office developed the *Executive Guide: Leading Practices in Capital Decision-Making* as a supplement to OMB’s more specific Capital Programming Guide. *The Executive Guide* “identifies attributes that are important to the capital decision-making process as a whole, as well as capital decision-making principles and practices used by outstanding state and local governments and private sector organizations.” The guide also provides information about the Coast Guard in an effort to determine the applicability of these principles and practices to a federal agency. *The Executive Guide* is not meant to be a detailed rulebook, rather it is meant to be illustrative in



nature and serve as a complement to the Capital Programming Guide. In constructing *The Executive Guide*, the GAO identified and studied several government and private organizations that are recognized for outstanding capital decision-making practices. The organizations studied are as follows:

- State of Maryland
- State of Minnesota
- State of Missouri
- State of Virginia
- State of Washington
- Dayton, Ohio
- Montgomery County, Maryland
- Phoenix, Arizona
- Ford Motor Company
- General Electric
- Mobil Corporation
- Texas Instruments

The Executive Guide divides the desired capital budgeting attributes into five broad principles as follows:

Principle 1: Integrate organizational goals into the capital decision-making process.

Principle 2: Evaluate and select capital assets using an investment approach.

Principle 3: Balance budgetary control and managerial flexibility when funding capital projects.

Principle 4: Use project management techniques to optimize project success.

Principle 5: Evaluate results and incorporate lessons learned into the decision-making process.

B. PRIVATE SECTOR CAPITAL BUDGETING PRINCIPLES AND METHODS

This section will describe the capital budgeting process for organizations in the private sector. Specifically, the section will define capital budgeting, discuss the primary capital budgeting decision criteria, introduce some guidelines that are used to make capital spending decisions, and explain how risk is incorporated into the capital budgeting process in the private sector.

1. Capital Budgeting in the Private Sector

Capital budgeting is the area of financial management that establishes the criteria for investing in long-term projects. More often than not, these projects involve the acquisition of property, plant, and equipment. Simply put, capital budgeting is “The decision-making process with respect to investment in fixed assets” (Keown et al., 2005). This decision-making process helps private organizations determine whether or not to accept or reject a proposed capital investment project. A fixed asset, also known as a capital asset, is defined as, “A long-term, tangible asset held for business use and not expected to be converted to cash in the current or upcoming fiscal year, such as manufacturing equipment, real estate, etc.” (<http://www.investorwords.com>). Since cash can be classified as a “benefit” to the



private firm, one can combine the two definitions above and restate the definition of capital budgeting as the decision-making process that is used to purchase assets that provide long-term benefits to the organization.

2. Capital Budgeting Criteria

Competition is intense in the private-sector marketplace. Once a firm comes up with a profitable investment project, competitors often rush in—which results in reduced prices and profits. Due to this, private-sector firms must have a strategy to consistently generate ideas for new capital projects. Without a consistent flow of new capital projects (or projects that improve existing products), the firm will not be able to grow, or even survive, in the private-sector marketplace. Like most public sector organizations, many private firms have Research and Development (R&D) operations or departments that are tasked with coming up with proposals for new capital projects and designing improvements to existing products (Keown et al., 291-292). How are the capital project proposals generated by R&D evaluated to determine profitability for the private firm?

Few methods are available to execute capital budgeting. These include the simple payback period method (PB), the net present value method (NPV), the profitability index (PI) method, and the internal rate of return method (IRR). Over the past fifty years, the focus on a particular method has shifted almost every decade. The internal rate of return and the net present value techniques slowly gained in popularity until today, where they are now used by virtually all major corporations in decision-making (Keown et al., 2005).

In addition to the existing methods, computer modeling recently became available to financial managers. This technique bridges the gap between theory and practical application.

Choosing the appropriate methodology to execute capital budgeting is very important. This review will discuss a few aspects of capital budgeting: net present value, the internal rate of return, the payback method, computer modeling, and risk considerations. Furthermore, it will introduce how the Fortune 1000 companies execute capital budgeting.

a. Net Present Value

The discounting methods of cash flow are based on discounting cash inflows and outflows to their present values. Therefore, this technique considers the time value of money. Clark, Hindelang, and Pritchard (1989) define the net present value computation as follows:

$$NPV = \sum_{t=0}^n \frac{CI_t}{(1+k)^t} - CO_0$$

CO = present value of the after-tax cost of the project

CI = the after-tax cash inflow to be received in period t

k = appropriate discount rate or hurdle rate

t = time period



n = useful life of asset

The goal of using this formula is to determine whether the net present value is equal to, less than, or greater than zero. If the NPV is positive, then the project is expected to yield a return higher than the required rate. If NPV is zero, then the yield and required rate are expected to be equal. Lastly, if NPV is less than zero, then the yield is expected to be below the required rate. The significance of the net present value results is that, normally, only those projects with a value equal to or greater than zero will be considered. This NPV formula was widely used in the 1990s. The formula being used today, according to Keown et al., (2005), has been slightly modified; yet, the goal remains the same.

$$NPV = \sum_{t=1}^n \frac{FCF_t}{(1+k)^t} - IO$$

FCF= annual free cash flow in time period t

K = the appropriate discount rate; that is, the required rate of return or cost of capital

IO = the initial outlay

N = the project's expected life

As Clark et al. (1989) observed:

We support our preference for the NPV model as the unique evaluation technique that consistently helps firms to maximize common shareholder's wealth positions. Whenever mutually exclusive projects are being evaluated, only the NPV model will consistently show the firm the project or set of projects that will maximize the value of the firm.

Today's view of using the NPV model for its benefits has not changed much. "Acceptance of a project using the NPV criteria adds to the value of the firm, which is in harmony with the private firm's goal of maximizing shareholder value" (Keown et al., 2005).

The use of the NPV method when selecting projects seems the most appropriate because it takes into account cash flows as opposed to accounting profits. It also considers the time value of money, which makes the calculation more realistic. Lastly, the NPV method is sensitive to the true timing of benefits received from a project. The only difficulty with the NPV method is accurately determining the exact required rate of return. To overcome this obstacle, many firms use the cost of capital as the required rate of return. This rate is the most emphasized in current finance practices.

The NPV capital budgeting decision method is superior to simpler capital budgeting decision methods for four major reasons:

1. It deals with free cash flows rather than accounting profits.
2. It is sensitive to the true timing of benefits received from a project.
3. It incorporates the time value of money which supports a rational comparison of a project's benefits and costs.



4. Acceptance of a project using the NPV criteria adds to the value of the firm, which is in harmony with the private firm's goal of maximizing shareholder value (Keown et al, 2005).

b. Internal Rate of Return

The internal rate of return is another discounted cash flow method used for capital budgeting decisions. By definition, the internal rate of return (IRR) is that rate which exactly equates the present value of the expected after-tax cash inflows with the present value of the after-tax cash outflows (Clark et al., 1989).

The internal rate of return is not easily identified. Few tools are available to determine the internal rate of return. One of these tools is identifying the discount factor. This calculation consists of dividing the initial outlay by the yearly average expected cash inflows. Upon finding the discount factor, it is compared against compound interest and annuity tables to determine what percentage corresponds to that specific discount factor. The percentage selected is then used as a starting number to multiply the cash inflows by until a NPV close to or greater than zero is found. Therefore, if the percentage selected does not give a NPV of zero or greater, then the number is adjusted up or down until it reaches the targeted value.

Once the IRR of a project has been determined, it is then compared to the required rate of return. The purpose is to decide whether or not the project is acceptable. If the IRR is equal to or greater than the required rate of return, then the project is acceptable. Of course, projects can also be ranked in accordance with IRRs. The project with the highest IRR would be rank number one, the second highest IRR would be ranked number two, and so forth.

There are cases where the sign of the cash inflows varies over the life of the project. This type of situation brings about variable internal rates of return. When encountering multiple IRRs over the life of a project, other evaluative calculations are used to account for the variability. This methodology, however, is very seldom practiced.

The Internal Rate of Return method requires estimating a rate of return based on the discount factor. Each discount factor does not have a unique corresponding rate. Therefore, financial managers use an "approximation" in selecting the IRR. The NPV calculation is more precise, and therefore is preferred over the IRR methodology for capital budgeting.

The internal rate of return (IRR) criterion helps private firms determine a capital project's rate of return. "Mathematically, it is the discount rate that equates the present value of the (cash) inflows with the present value of the (cash) outflows" (Keown et al., 2005). A capital project is accepted by the firm if its IRR is greater than the firm's required rate of return (i.e., cost of capital). On the other hand, a capital project is rejected if its IRR is less than the firm's required rate of return. The IRR method exhibits the same advantages as the NPV method and yields similar accept-reject decisions. However, the reinvestment rate assumption imbedded in the IRR method is inferior to that of the NPV method (Keown et al., 2005).

c. Payback Method

The payback method uses the number of years of cash flow required to recapture the original cost of an investment, normally disregarding salvage value (Osteryoung, 1979). There are two approaches to calculating the payback value. The first method is used when annual cash flows are equal in value. For example, if the initial outlay of a project is \$20,000, the life of the project is five years, and the annual cash flow is \$2,000 then the payback calculation is as follows:

$$\text{Payback} = 20,000/2,000 \quad \text{Payback} = 10 \text{ years}$$

The second method of calculating the payback value is applicable when the annual cash flows are unequal. In this case, two calculations take place: the annual cash flow and the cumulative cash flow. The values of the cumulative cash flows are used in calculating the payback. Table 1 illustrates uneven cash flows and the payback computation.

Table 1. Evaluation of Projects (Osteryoung, 1979)

Table I. Evaluation of Projects with Unequal Cash Flow Using Payback		
Initial Cost \$15,000 Life (in years) 5		
Year	Annual Cash Flow	Cumulative Cash Flow
1	\$2000	\$2,000
2	4000	6,000
3	6000	12,000
4	7000	19,000
5	3000	22,000

The cumulative cash flow in any year is the summation of the prior year's cumulative total and the annual cash flow for the current year. The initial cost for this project was \$15,000, which is not clearly identified as a cash flow. Therefore, to find the payback, a bracket must be identified where \$15,000 falls in. In this case, the initial outlay of \$15,000 falls between \$12,000 and \$19,000. As a result, the payback time for this project will be 3 years and a fraction. To compute the fraction, the difference between \$15,000 and \$12,000 (\$3,000) will be divided by the next cash flow, which is \$7,000. The fraction then results in a value of 0.43. The final payback period is 3.43 years.

Calculating payback is a very simple method. Smaller firms whose budgets are limited are more prone to use the payback method based on its simplicity. However, the payback method does not account for additional cash flows after the payback period, which neglects including the value of the additional cash flows in the decision-making process.

Another disadvantage of the payback method is that it neglects the relationship of timing and yields.

d. Inflation and Discount Rates

One of the most difficult challenges in using quantitative methods to determine the feasibility of capital investment projects is to accurately determine inflation and discount rates over the life of a project.

Drury and Tayles (1997) in their article "Misapplication of Capital Investment Appraisal Techniques," observe: "Firms are guilty of rejecting worthwhile investments because of the improper treatment of inflation in the financial appraisal. Inflation affects both future cash flows and the cost of capital that is used to discount the cash flows." Cash flows can be expressed in real terms (today's current purchasing power) and nominal terms (purchasing power at the time the cash flow occurs). Therefore, inconsistency in using nominal versus real terms can lead to miscalculations of the real value or benefits of a project. As a result, the NPV of projects can be understated or overstated. Long-term projects are most susceptible to mismatching of inflation because failing to include inflation in cash flows estimates compounds with time.

In other cases, some cash flows do not fully adjust with the general rate of inflation or simply do not adjust at all. For example, lease payments and fixed-price purchase or sale contracts do not change with the inflation rate. Therefore, to convert future cash flows to real cash flows, they must be deflated by the general rate of inflation.

e. Computer Modeling and Capital Budgeting

Among the many benefits technology has brought about, simulation modeling is one of the applications beneficial to capital budgeting. Computer modeling has become one of the most important tools in an attempt to close the gap between theory and application. When considering capital budgeting, "Special attention must be paid to the timing of receipts and outlays; and the handling of fixed and variable costs, accounting depreciation, working capital, interest expense and opportunity costs" (Harris, 1982). In capital budgeting, projects are evaluated by considering the incremental cash flows resulting from the investment. There are two specific aspects to consider when working with cash flow projections: the investment decision (which projects to undertake) and the financing decision (how will the projects be financed). Computer modeling can include many of the theoretical implications while integrating real-life investment factors and financing decisions. The model can be established to dynamically show transformations over the life of the project as a result of economic changes, like changing market rates or declining asset usage. Furthermore, a firm's ending cash-balance comparisons can be included with and without the project. Modeling is very useful in cash-flow projection. The models can help eliminate some of the theoretical uncertainties of net present value analysis.

Harris (1982) states: "There are six steps involved in developing and using a computer model when analyzing capital projects: 1) Define the model, 2) gather information, 3) develop the baseline forecast, 4) evaluate the baseline forecast, 5) perform a sensitivity analysis, 6) evaluate capital expenditures."

As described by Harris, the first step in building a capital project model is to define the model. In defining the model, the following relevant factors should be included: 1) level



of complexity, 2) list of inputs, 3) list of desired outputs, 4) number of programs to be evaluated, 5) the extent of interactions and linkages between programs, and 6) financial information. The next step is to gather information. The amount of information to be gathered will be dependent on step one. The scope of the information can include financial, statistical, fiscal, budgetary, and demographic data. The third step is to build a baseline forecast. This forecast includes two phases. One of the phases covers the estimated demand for the capital asset and estimated usage, while the other encompasses the financial forecasts associated with such demand. Once the baseline has been established, step four will evaluate the baseline forecast. Evaluating the baseline consists of management reviewing the forecast's reasonableness, validity, and accuracy.

When evaluating the baseline, management must take into account trends in utilization, financial condition, profitability, required rate increases, and the attractiveness of the cash flows. Step five consists of performing a sensitivity analysis. Many firms use Excel-based applications, such as linear programming in Excel Solver, to produce a sensitivity analysis report. This report presents the marginal change or effect resulting from changing the variables' values within the model. Another approach to conducting a sensitivity analysis is to incorporate assumptions relating to capital expenditures to assess the incremental effect on a capital program. The analyst can determine a possible distribution of outcomes by modifying exogenous assumptions (i.e., inflation rates) and assigning probabilities to the possible range of changes. Based on these outcomes, ranging from least probable to most probable, management can better prepare for offsetting those undesirable results. Harris observes that the last step is to evaluate capital expenditures. This step relates to modifying investment expenditures and the effects these changes have on possible outcomes.

Computer modeling offers speed and accuracy in simulating complex situations for capital budgeting. Additionally, modeling offers analysts a dynamic medium in which to assess many different and possible outcomes.

3. Capital Budgeting Guidelines

Like many organizations in the public sector, private firms have guidelines or "rules" that apply to the capital budgeting process. However, unlike the specific rules and laws that federal agencies (such as the DoD) must follow when proposing capital investments, these guidelines are not "written in stone." Essentially, the guidelines used by private firms exist for one purpose, and that is to help firms determine how to measure the value of capital investment projects. The decision criteria discussed above assumed that a capital project's cash flows were known. In reality, estimating the cash flows associated with a particular capital investment project is a difficult process. Additionally, not all cash flows associated with a capital project are relevant in measuring its value. The guidelines detailed in the next several paragraphs help private firms measure the value of capital projects by defining relevant cash flows (Keown et al., 2005).

The first guideline is that private firms should use free cash flows rather than accounting profits to measure the value of capital projects. Accounting profits are "booked" when "earned," which may or may not mean that the firm actually has "cash in hand." Free cash flows from a project can be reinvested by the firm and they "correctly reflect the timing of benefits and costs—that is, when the money is received, when it can be reinvested, and when it must be paid out" (Keown et al., 2005).



Another guideline is that firms must only consider the *incremental* cash flows associated with the acceptance of a capital project proposal. This requires firms to look at the company as a whole and determine after-tax cash flows both with and without the project. Additionally, incremental expenses must be considered. Will the purchase of new machinery require that employees receive additional training? If so, the cash flow associated with this training must be subtracted from the expected cash inflows of the new machinery (Keown et al., 2005).

Next, private firms must consider how the capital project will affect the cash flows from existing products and operations. For example, if a firm is considering the launch of a new product line, it must thoroughly analyze the expected effects (in terms of cash flows) this will have on their current product lines. Will the new product cannibalize sales from existing products or will the new product bring increased sales to existing products? Questions like these, as well as many others, must be answered before a new capital project is accepted (Keown et al., 2005).

Finally, private firms must remember to consider sunk costs and opportunity costs during the capital budgeting process. Sunk costs are cash flows that have already been spent on the project. For example, if a firm has already spent money for a market feasibility study of a new product, the cash flow associated with this expense is “sunk” and should not be included in the capital budgeting analysis. Opportunity costs are “cash flows that are lost because a given [capital] project consumes scarce resources that would have produced cash flows if that project had been rejected” (Keown et al., 2005). For example, if a firm owns vacant land and builds a strip mall on it, the opportunity cost for the strip mall project is the forgone cash flows if the land had been used for some other purpose. Keown makes this final point about opportunity costs: “opportunity cost cash flows should reflect net cash flows that would have been received if the project under consideration were rejected. Again, we are analyzing the cash flows to the company as a whole, with or without the project” (2005).

4. Risk and Capital Budgeting

Capital budgeting requires financial managers to make decisions regarding the commitment of resources to courses of action that are normally very expensive. Additionally, more often than not, these decisions are very costly and not reversible. To have successful outcomes in capital budgeting, managers must accurately anticipate future business and economic conditions. Risk, therefore, can be described as the delta between the decisions made and actual future outcomes. To deal with risk and choices in an appropriate and preferably objective, manner, management must evaluate all capital investment proposals as rigorously as possible. As the volatility of the business environment increases, those firms who are best able to navigate these uncertainties will prove to be the most successful in the long run.

In evaluating capital budgeting decisions, financial managers must carefully identify and qualify financial risks. Two main considerations financial managers must take into account are:

1. Are they aware of all future states of the economy, business, and market trends?
2. Are they able to place a probability and value on each of those states?



To better understand how managers evaluate or attempt to answer these questions, several terms must be defined. Clark et al. (1989) highlight five specific types of risks: business, investment, portfolio, cataclysm, and financial. These risks are defined by Clark et al as follows:

- **Business risk** is the variability in earnings that is a function of the firm's normal operations (as impacted by the changing economic environment) and management's decisions with respect to capital intensification. It should be noted that business risk considers only the variability in Earnings before Interests and Taxes (EBIT).
- **Investment risk** is the variability in earnings due to variations in the cash inflows and outflows of capital investment projects undertaken. This risk is associated with forecasting errors made in market acceptance of products, future technological changes, and changes in cost related to projects.
- **Portfolio risk** is the variability in earnings due to the degree of efficient diversification that the firm has achieved in its operations and its overall portfolio of assets.
- **Cataclysm risk** is the variability in earnings that is a function of events beyond managerial control and anticipation.
- **Financial risk** is the variability in earnings that is a function of the financial structure and the necessity of meeting obligations on fixed-income securities.

Based on the many risks described above, managers must draw from a group of alternatives to quantify the risks they face. Statistical methods and simulation are two of the most widely-used approaches to determine risk probabilities and values.

Statisticians have presented both the absolute and relative measures of risk. Absolute measures of dispersion include the range, mean absolute deviation, variance, standard deviation, and semi-variance. The relative measure of dispersion is simply the coefficient of variation. Each measure has a unique equation to determine its value. Additionally, all of these measures present high and low benchmarks against which to compare and determine the risk of the investment.

Once the measures have been computed, a comparison and interpretation must be done among all the possible investments and the correlations of the measures to determine which alternative is the best overall. The absolute statistical measures provide valuable insight with regards to risk. Mainly, the relative measure of dispersion or coefficient of variation indicates the level of risk per dollar of expected return. Lower coefficients of variation translate into lower risk.

5. Incorporating Risk into the Capital Budgeting Process

Not all projects can be treated equally in regards to risk. Each investment project has its unique level and type of risk. Therefore, to properly incorporate risk into investment analysis, two methods have been developed. These two methods are the certainty equivalent approach and the risk-adjusted discount rate.

In the 1980s, the concept of certainty equivalent was described as follows: "The certainty equivalent method permits adjustment for risk by incorporating the manager's utility preference for risk versus return directly into the capital investment process" (Clark et al., 1989).



This concept has remained consistent in its purpose throughout time until the present. Keown et al. (2005) presents a more updated definition: the certainty equivalent approach involves a direct attempt to allow the decision-maker to incorporate his or her utility function into the analysis. This approach allows the financial manager to substitute a set of equivalent riskless cash flows for the expected cash flows. Subsequently, these cash flows are discounted back to the present using the NPV criteria. Once the calculation is completed, the project with a net present value equal to or greater than zero is selected. While this approach accounts for the utility factor, it can be an arbitrary approach. Two different financial managers can look at the same project with different riskless rates. Therefore, if presented with this situation, which of the two managers is correct? In reality, both managers could be right since the riskless measure is based on a relative assessment as opposed to a hard factual guideline. This approach is not widely used because of the potential bias that can stem from the “riskless” assessment.

The next approach is the risk-adjusted discount rate. The definition used in the 1980s was: “The rationale underlying the use of the risk-adjusted discount rate (RADR) technique is that projects which have greater variability in the probability distributions of their returns should have these returns discounted at a higher rate than projects having less variability of risk.” The RADR concept concentrates on the variability of risk. Therefore, it adjusts the discount rate to accommodate greater or lesser risk. Likewise, today’s approach to this method focuses on the same principle. “A method for incorporating the project’s level of risk into the capital-budgeting process, in which the discount rate is adjusted upward to compensate for higher than normal risk or downward to adjust for lower than normal risk” (Keown et al., 2005).

The method of risk-adjusted discount rates seems more plausible when incorporating risk into capital budgeting for two reasons. First, financial analysts should consider the stakeholders reactions to new investments if the risk associated with them is different that the firm’s typical risk. Second, adjusting the discount rate upward or downward accounts for the variability of returns based on risk.

The most significant difference between the two methods hinges on the point at which the adjustment for risk is incorporated into the calculations. Also, the risk-adjusted discount rate makes the implicit assumption that risk becomes greater as time windows expand.

Based on the many risks described above, managers must draw from a group of alternatives to quantify the risks they face. Statistical methods and simulation are two of the most widely-used approaches to determine risk probabilities and values.

The previous discussion has ignored the role of risk and uncertainty in private-sector capital budgeting. In fact, even when firms use the criteria and guidelines detailed above, the cash flows used in their analysis of a capital project are only estimates of “what is *expected* to happen in the future, not necessarily what *will* happen in the future” (Keown et al., 2005). However, even though private firms can not know with 100% certainty what cash flows will result from investing in any particular capital project, they can estimate a range of probabilities for the cash flows. Likewise, private firms will have to make estimates on interest rates related to their future costs of capital.

The more common method the private firms use for incorporating risk is through risk-adjusted discount rates. The use of this method is “based on the concept that investors



demand higher returns for more risky projects” (Keown et al., 2005). In this process, the discount rate used in the NPV criterion is adjusted upward or downward in accordance with the level of risk inherent in the capital investment under consideration. If a capital project is determined to be riskier than normal, the discount rate is adjusted upward. If the level of risk for the project under consideration is higher than the firm’s “typical” project, then management must assume that the firm’s shareholders will demand a higher rate of return for taking on this additional risk. By appropriately adjusting the discount rates for the risk level of the project under consideration, the firm can ensure to the best of their ability across a portfolio of projects that their capital budgeting analysis will yield projects that increase the profits of the firm and ultimately increase shareholder value (Keown et al., 2005).

REFORM OPTIONS

This research examined the capital budgeting practices and principles used in both public- and private-sector organizations. The Government Accountability Office (GAO), President Clinton’s Commission to Study Capital Budgeting (PCSCB), and others performed several studies which resulted in several proposed improvements to the current system of capital budgeting in the federal government.

First, if budget reforms are going to be made, management reforms must be made simultaneously to ensure the reforms are properly implemented and all persons involved are aware and able to make the appropriate changes. This is especially true if one of the reforms is decentralizing the decision-making process. Decentralizing the decision-making process could prompt the use of performance budgeting, where departments are rated (and rewarded) on their success of reaching predetermined goals. Authority for capital asset purchases could be shifted down to the department level (i.e., the DoD would decide which assets to buy) instead of Congress holding virtually all decision-making authority. Even though SECDEF Rumsfeld’s request for “broadened discretionary powers” in the Defense Transformation Act (DTA) was denied by Congress, his ideas have considerable merit since the departments are the most closely involved with the day-to-day business they conduct (McCaffery & Jones, 2004).

Since federal agencies have much tighter constraints than businesses in the private sector, it is difficult to provide incentives for agencies to manage their assets. However, along with continued use of the Bush Administration’s Performance Assessment Rating Tool (PART), Congress could adopt policies similar to Australia and New Zealand and allow the agencies, including the DoD, to raise and keep revenues from selling or renting out existing assets (President’s Commission to Study Capital Budgeting, 1999). If good PART scores are rewarded in the budget process and agencies are allowed to keep revenues from the sale of assets, there are at least two incentives for agencies to manage their assets well.

If performance-based budgeting is used, the strategic plans of the departments could play a much larger role in the capital budgeting process. Although the Government Performance and Results Act (GPRA) requires agencies to submit five-year strategic plans, the plans are only prepared every three years and are currently not used directly in considering appropriation requests, which includes requests for capital spending. If a move towards performance budgeting and a more decentralized decision-making process was made, these plans would need to have results-oriented goals that could be measured, so that agencies could be rated on their performance (possibly via PART). For the DoD, this would mean that the Future Years Defense Plan (FYDP), DoD version of the agency capital plan, would play a larger role in the decision-making process regarding capital asset



purchases. Also, the Office of Management and Budget (OMB) should evaluate the plans and Congress should use the strategic plans and OMB evaluation as decision-making tools when considering appropriation requests. Taking into account the considerable amount of time that most federal agencies spend preparing their strategic plans in accordance with GPRA, it seems reasonable to suggest that these plans be used for decision-making purposes.

Additionally, it would be useful for planning purposes if the strategic plans and budgets were tied to the lifecycles of the capital assets. Although the Capital Programming Guide directs agencies to consider lifecycle costs and compare them to expected benefits, the lifecycle costs are not directly linked to the agency's strategic plans. If the capital asset's lifecycle costs were tied to strategic plans, funding for the maintenance and replacement of assets could be planned in advance. The plans should also include any future outlays for capital assets that are planned (such as land, buildings, and new weapon systems). If a lifecycle is estimated for an asset, then the department would know when it will be necessary to replace the item, and this can be included in the plan. Therefore, even if there is no proposal or recommendation for the actual item that will replace the asset, funding needs can be more accurately forecasted (President's Commission to Study Capital Budgeting, 1999).

In an effort to assist agencies in making decisions on capital asset investments, the agencies should continue to prepare annual financial statements as required by the CFO Act. It should be noted, however, that preparation of financial statements simply for CFO compliance should not be the goal. The goal should be preparation of financial statements that are used to aid in better decision making. In addition, the agencies could prepare detailed breakdowns of existing capital assets. The information in these reports would then be consolidated by the OMB and used to assist the agencies in preparing long-term capital plans, similar to DoD FYDP, as well as to assist OMB in reviewing and assessing those plans (President's Commission to Study Capital Budgeting, 1999).

Most states have separate capital budgets. Analysis of the case study on state capital budgets prompts the question of if there should be a separate capital budget at the federal level. While there are many critics of a separate capital budget at the federal government or agency level, there has been a proposal for instituting separate capital acquisition funds (CAF) at the agency level. A segment of the agency's appropriations would be placed in the CAF and could only be used for acquiring large capital assets. The CAF would borrow from the Treasury and charge operating units rent equal to the amount of debt service. Additionally, the CAF would inherit all of the agency's existing capital assets in an effort to capture all agency costs of capital. Separate funds for capital acquisition should help agencies better plan and budget for capital assets. The agencies could then be held accountable for planning and budgeting and, presumably, would be more likely to use their resources efficiently. These funds would also smooth out the budget authority required by agencies and would help to reduce potential spikes in the budget associated with full funding requirements. An important aspect of introducing separate capital acquisition funds, however, is the definition of capital assets. OMB would have to issue guidance on what constitutes a capital asset to ensure implementation is consistent throughout the agencies (President's Commission to Study Capital Budgeting, 1999).

While the Government Accountability Office (GAO) originally agreed with and supported the President's Commission to Study Capital Budgeting recommendation to



implement capital acquisition funds, they have recently published a study stating that the proposed benefits of CAFs can be achieved through simpler means (GAO, 2005).

The GAO states that CAFs, as a financing mechanism for federal capital assets, would ultimately increase management and oversight responsibilities for the Treasury Department, the Office of Management and Budget (OMB), the Congressional Budget Office (CBO), and the departments and agencies that would utilize CAFs. While recognizing that CAFs might improve decision-making and remove (for the most part) spikes in Budget Authority (BA) associated with large dollar capital assets, GAO states that some federal agencies are using different approaches that address these problems through much simpler means (GAO, 2005).

The federal agencies that the GAO studied are using asset management systems which are allowing them to assess the condition of existing capital assets, estimate funding levels for maintaining these assets, and assign priorities to maintenance and improvements for capital assets. Other agencies are currently using cost information from their accounting systems to assist in the agency's budgeting decisions. However, additional improvements in agency cost-accounting systems is needed before they can fully inform the agency's capital planning and budgeting decisions (GAO, 2005).

The GAO's study of several capital-intensive federal agencies, coupled with several interviews with officials from Congress, Treasury, and the OMB, has led them to conclude that CAFs, as they had been proposed by the President's Commission to Study Capital Budgeting, are too complicated for implementation because of the additional budget complexities that they create. Additionally, interviews with executive and congressional officials led the GAO to believe that a proposal to institute CAFs, even on a pilot basis, would have few, if any, proponents. Because of these reasons, the GAO recommends that the focus should be placed on improvement and widespread implementation of asset management and cost-accounting systems to address the problems that CAFs were proposed as a solution for (GAO, 2005).

Spending caps could be placed on capital spending to encourage decision-makers to set priorities and make tradeoffs, which could result in capital spending that provides the most benefit. This could be done in the context of re-instating the Budget Enforcement Act spending caps that have expired. With spending caps, decision-makers would focus resources on achieving the long-term objectives and spend capital dollars on the most cost-effective assets (President's Commission to Study Capital Budgeting, 1999), much like what is common practice in private-sector organizations. Agencies will also ensure that capital assets invested in are required to accomplish their mission as defined by their strategic plan.

While spending caps encourage efficient trade-off decisions, when combined with the current full-funding requirements, spending caps can lead to a bias against capital projects in the budget process. However, as previously noted, full funding in the current budget process is important for controlling acquisition costs and ensuring adequate resources to operate and maintain capital assets. Although there seems to be incompatibility between spending caps and full-funding, the GAO has identified strategies that have been successfully used by selected agencies to accommodate capital spending within the current budget controls imposed by Congress (Posner, 1998). These strategies take into account the presumed reluctance of Congress to approve separate capital budgets, capital acquisition funds, or decentralized decision-making at the agency level.



CONCLUSIONS

The current practices of the DoD and the federal government are clearly less than perfect and often lead to capital asset expenditures that are not as efficient or as effective as needed. Obviously, if discretionary dollars continue to be limited, and the current budgeting practices are leading to inefficient and ineffective use of capital dollars, something needs to change. Budgeting changes at the federal government level would certainly require Congressional and Executive commitment if any progress is to be made. Some of the recommendations require Congress to give federal agencies more control of their budgets; and there has been very little Congressional interest in sharing their “power of the purse.” The result has been efforts, in the form of laws and regulations, mandating federal agencies to be more efficient in their use of resources with an emphasis in becoming more “business-like.”

Recent efforts by the DoD and other federal agencies have improved conditions to some degree. Several foreign governments and many states have been successful in implementing capital budgeting practices that are prevalent in private-sector companies. Likewise, the DoD and other federal agencies have instituted some of these same practices. However, more progress needs to be made. More research should be done, and serious commitments need to be made from Congress and federal agencies to improve the budgeting processes. Thorough examination of private-sector capital budgeting practices in states and other countries coupled with proposals made by the PCSCB, the GAO, and others, provide valuable insights with respect to changes that should be assessed in terms of their application in the Department of Defense.

In our view, the Department of Defense (and most of the federal government for that matter) should adopt and implement capital budgeting. In doing so, the DoD probably ought to completely discard PPBES¹ and replace it with a long-range and accrual-based planning and budgeting process, i.e., ending what we know as programming and the POM. In effect, programming is only effective at the end-game anyway—but preparing and processing the POM wastes huge amounts of valuable DoD staff time and energy that can be put to better use. Also, ideally, the period for obligation of *all* accounts in the new DoD budget process would permit obligation over a period of two or three years for all accounts—including fast spend accounts including O&M, MILPERS, etc. The reason for multiple-year obligation for all accounts is to enable more effective budget execution and end the highly wasteful and inefficient end-of-year “spend it or lose it” incentive syndrome. This change would, of course, require the approval of Congress. However, the DoD could implement long-range budgeting (including capital budgeting) as a part of the overall reform—while Congress continues to operate on the annual budget cycle it prefers (for a number of reasons related to serving constituent and member interests). No change in the federal budget process can be made unless it permits Congress to continue to do its business according to the incentives faced by members. To think otherwise is naïve. Still, as noted above, the only part of the reform advocated here that would require explicit congressional action is lengthening the obligation period for all accounts to two or three years (as has been done internationally, in the UK and other countries, for example). This change would require Congress to modify certain provisions of appropriation law. Otherwise, the DoD could implement a long-range accrual based budgeting system on its own, subject to gaining approval of and support for it from Congress—but it would not require change in law. In essence, it is incumbent on the DoD to persuade Congress to support the change—and this will only occur if the DoD is able to show members how they, the DoD and the American taxpayer will be better off as a result of the reform.



In addition, the defense acquisition decision process is so flawed and excessively bureaucratic that it, too, should be replaced completely by a new process that would enable capital asset investment analysis of alternatives, decision making and execution in a much shorter period of time, involving far fewer participants, and in synchronicity with a long-range planning and accrual budgeting process that places emphasis on performance rather than input and process variables. The system, as it operates presently, is an incredible and wasteful triumph of process over substance. Also, we wish to observe that if we really want to run the DoD like a business (i.e., using smart business practices) the best way to accomplish this goal is to make it a business— through increased contracting of all essentially non-governmental functions to the private sector. In our view, so much of what the DoD acquisition and contracting bureaucracy does (and does badly) could and should be performed entirely outside of government. However, full exploration of these proposals must and will be made in other papers, the research for which is ongoing as we complete writing this document.

¹Some might argue that the milpers and O&M accounts should be kept in a modified PPBE-like process. We have no problem with this idea, but divorced of capital asset decisions, keeping PPBE as a budgeting system seems overly bureaucratic. What system the remaining DoD accounts should use is another good topic of inquiry with the basic question being what kind of system serves a set of accounts (one of which is highly stable—milpers, civpers in O&M) and one (O&M) which is relatively stable at the topline, but riddled with within-year adjustments and shot with pork and Congressional-interest items not requested by the DoD.

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Budgeting for Capabilities Based Planning

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Executive Summary

The Department of Defense (DoD) and many of its agencies are implementing capabilities-based strategic management and planning systems. Concurrently there are also other major initiatives underway, including DoD Transformation and AFSO21, that are specifically addressing changing capability requirements and process-improvement initiatives. Some have questioned whether there are sufficient budgetary resources available to implement the results of these initiatives. As our nation's security challenges are becoming more complex, our military is transforming into an increasingly agile joint force. This new, highly flexible DoD requires an equally flexible and responsive business, financial and budgeting support infrastructure that is capable of adapting to an ever-changing operational landscape while ensuring adequate financial resources are available. Capabilities-based strategic planning may be the answer. It differs from the traditional "threat-based" planning by focusing on internal agency assets and processes rather than specific external threats. Using this approach at multiple levels of an agency or organization, with top-level integration focused on agency mission and key outcomes, allows the most efficient budgetary allocation of resources and promises better performance against a poorly defined or understood threat. This presentation reviews the academic theory behind capabilities-based strategic planning and ties it to current budgetary processes.



Panel – Initiatives in Procurement and Acquisition

Wednesday, May 17, 2006	Initiatives in Procurement and Acquisition
3:15 p.m. – 4:45 p.m.	<p>Chair:</p> <p>Shay Assad – Director, Defense Procurement and Acquisition Policy</p> <p>Discussant:</p> <p>David Lamm – Naval Postgraduate School (emeritus)</p> <p>Papers:</p> <p><i>A Transactions Cost Economics Approach to Defense Acquisition Management</i></p> <p>Raymond (Chip) Franck, Naval Postgraduate School</p> <p>Francois Melese, Naval Postgraduate School</p> <p>John Dillard, Naval Postgraduate School</p> <p><i>Development of Measures of Success for Corporate Level Air Force Acquisition Initiatives</i></p> <p>Lt Col Bryan Hudgens, USAF, Naval Postgraduate School</p> <p>Capt Carey Petit, USAF, Warner-Robins</p> <p>Col Rita Jordan, USAF, US Air Force Academy</p> <p>Lt Col Leon A. Mable, USAF (ret.), Air Force Institute of Technology</p>



A Transactions Cost Economics (TCE) Approach to Optimal Contract Type

Presenter: Raymond (Chip) Franck, Senior Lecturer, Graduate School of Business & Public Policy, Naval Postgraduate School, retired from the Air Force in 2000 in the grade of Brigadier General after thirty-three years commissioned service. He served in a number of operational tours as a bomber pilot; staff positions which included the Office of Secretary of Defense and Headquarters, Strategic Air Command; and was Professor and Head, Department of Economics and Geography at the US Air Force Academy. His institutional responsibilities at NPS have included the interim chairmanship of the newly-formed Systems Engineering Department from July 2002 to September 2004, teaching a variety of economics courses, and serving on a number of committees to revise curricula for both the Management and Systems Engineering disciplines. His research agenda has focused on defense acquisition practices and military innovation.

Francois Melese, PhD, joined the NPS faculty in 1987. He earned his undergraduate degree in Economics at UC Berkeley, his Master's at the University of British Columbia in Canada, and his PhD at the Catholic University of Louvain in Belgium. After five years as a faculty member in the Business School at Auburn University, Francois joined NPS as part of the Defense Resources Management Institute (DRMI). In his time at NPS, he has taught public budgeting and defense management in over two dozen countries and has published over 50 articles and book chapters on a wide variety of topics. More recently, at the request of the State Department and NATO Headquarters, he has represented the US at NATO Defense meetings in Hungary, the Ukraine, Germany and Armenia. His latest article (co-authored with Jim Blandin and Sean O'Keefe) appeared in the *International Public Management Review*. The article (available at www.ipmr.net) is entitled "A New Management Model for Government: Integrating Activity-Based Costing, the Balanced Scorecard and Total Quality Management with the spirit of the Planning, Programming and Budgeting System."

John Dillard joined the NPS faculty in the fall of 2000 with extensive experience in the field of systems acquisition management. His research focuses on defense acquisition policy and its implications. Dillard began his career in program and contract management after attaining a MS in Systems Management from the University of Southern California in 1985. He has been involved with myriad technologies and system concepts that have evolved into fielded products, such as the M-4 Carbine, 120mm Mortar, and M-24 Sniper Weapon. He was the Assistant Project Manager for Development of both the Army Tactical Missile System and, later, the JAVELIN Antitank Weapon System at Redstone Arsenal, Alabama. All of these systems incorporate state-of-the-art technologies, are in sustained production and fielding, and are now battle-proven. He was the Product Manager for the Joint Advanced Special Operations Radio System, and in 1998 was appointed to head Defense Department contract administration in the New York metropolitan area. John has consulted for the governments of Mexico and the Czech Republic on achieving excellence in the public sector. As an adjunct professor for the University of California at Santa Cruz, he teaches courses in project management and leadership to Silicon Valley public and private industry professionals.



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Abstract

This study examines defense acquisition through the new lens of Transaction Cost Economics (TCE). TCE is an emergent field in economics that has multiple applications to defense acquisition practices. TCE's original focus was to guide "make-or-buy?" decisions that define the boundaries of a firm. This study reviews insights afforded by TCE that impact government outsourcing ("buy" decisions), paying special attention to defense procurement.

The study offers a brief synthesis and review of current Defense acquisition practices. The Department of Defense (DoD) is a unique enterprise that relies heavily on outsourcing. Outsourcing transactions are governed using a wide variety of contracts that share risk between the government and the contractor. Cost, schedule, and technical performance are widely accepted as success parameters in public and private transactions. While recently enacted defense acquisition practices address many of the issues raised by TCE, a key concept called "asset specificity" seems to have been overlooked. The "lock-in" effect achieved by contractors that invest in specific assets, while benefiting the government in the short run, can haunt the government in the long run. The risk is that, after winning a bidding competition, a contractor that invests in specific assets might eventually become a sole supplier that "holds up" the government, resulting in higher costs, schedule delays, or disappointing performance. We discuss some new and old solutions to the "holdup" problem.

We conclude by offering a number of insights for defense acquisition program managers generated by the new perspective of TCE. Whereas there is no universal template for the management and governance of complex and uncertain defense outsourcing relationships, TCE offers a valuable new perspective to improve the design and management of those relationships.



SECTION 1: INTRODUCTION

This report offers insights for those involved in procurement and acquisition management from a relatively new field in Economics called Transaction Cost Economics (TCE). We begin with a summary and synthesis of TCE—its roots, useful principles for formulating acquisition strategy, and implications for acquisition management in the Department of Defense (DoD). We then offer a synthesis of management practices in DoD, presenting examples of defense acquisitions and their associated governance strategies. We conclude with recommendations about how the application of fundamental principles of TCE might improve current defense acquisition management practices.

A) Antecedents of the Project

This paper is part of an ongoing effort to apply the insights of Transaction Cost Economics to DoD acquisition management practices (see Franck & Melese 2005).¹ Transaction Cost Economics (TCE) is the study of the “vertical” boundaries of business enterprises—defined primarily by what goods and services are produced within the firm (“make”) and which are acquired from the market (“buy” or “outsource”). TCE has a well-established niche in economics as an academic discipline. Among the pioneers of this literature are Nobel Prize winner Ronald Coase and Oliver Williamson. TCE is also a major feature in a movement called the “New Institutional Economics.”² Unfortunately, these literatures focus almost exclusively on the private sector. More recent work by Pint and Baldwin (1997), Franck and Melese (2005), and others have begun to study TCE in a government setting—yielding some interesting insights.

B) Early Insights from TCE

The initial focus of the work by Franck and Melese (2005) was to examine the key document that guides all federal policy for the competition of commercial activities—Office of Management and Budget (OMB) Circular A-76. For competitive sourcing competitions between a government activity and private sector suppliers, OMB A-76 calls for a one-time 10% production cost advantage to justify outsourcing.

Applying TCE suggests one size does not fit all. Outsourcing relationships vary widely in their characteristics and potential difficulties. A key insight is that increases in transaction costs (required to govern an outsourcing relationship) can more than offset any production cost advantages from outsourcing. Herein, the authors extend their observations

¹ Serious research into TCE at the Naval Postgraduate School (NPS) began in the late 1990s with Prof. Francois Melese’s inquiries into the relevant literature and applications to government. The intent of this research is to highlight TCE insights useful for public sector acquisition and, accordingly, to improve defense acquisition management practices. Raymond Franck, also at NPS, joined this effort a few years later. Products of this effort so far include several conference presentations, one student thesis (jointly advised by Melese and Franck), and one paper published in the proceedings of the Second Annual NPS Acquisition Research Symposium Proceedings in 2005.

² A good summary of New Institutional Economics is available (for example) in *Wikipedia*, http://en.wikipedia.org/wiki/New_institutional_economics.



to the acquisition of major weapon systems, which largely employ similar outsourcing relationships.

The standard example is where ex-ante competitive bidding leads to an ex-post bilateral monopoly situation. The risk is that the winning supplier can lock-in the government by making investments in productive assets that are specific to the relationship (and that have little value outside the relationship). While initially advantageous, such investments in specific assets can make it prohibitively costly for other companies to compete in subsequent re-bidding of the contract. As a result, outsourcing relationships can involve extra transaction costs such as measurement, monitoring, and negotiation costs that can quickly overwhelm a simple 10% production cost advantage.

The lesson is that transaction cost considerations need to be added to the current exclusive focus on production costs in OMB Circular A-76. This also suggests more attention be granted to: the proper bundling of goods and services; investing in a well-defined Performance-Work Statement; clearly defining the terms of the contract—to include appropriate incentives; understanding the true costs of the transaction; and carefully designing mechanisms that will govern the outsourcing relationship. The next step is to extend these insights to DoD acquisition management practices.³

C) Outline of the Report

Section 2 of this report offers a summary and synthesis of the TCE literature. It explores the issues of incentives built into contracts, hedged (or tapered) outsourcing, and issues of governance. Section 3 presents a description of the principle components of defense acquisition transactions that are the most typical: research & development and procurement of weapon systems, along with a summary and synthesis of associated practices in defense acquisition management—to include contract structure and governance of the relationship. Finally, Section 4 offers a synthesis of these two bodies of knowledge. It considers similarities and differences in perspectives and explores possibilities for mutually beneficial sharing of concepts. The section concludes with proposals based on applying TCE principles and insights to DoD acquisitions.

³ To do so requires collaboration with those having a practitioner's expertise in this area. This occurred when our co-author John Dillard joined this research project. He is largely responsible for the comprehensive review of transaction components and current practices described in Section 3 of the study.



SECTION 2: REVIEW OF TRANSACTION COST ECONOMICS

Faced with ballooning budget deficits, growing entitlements, and an aging workforce, the federal government is searching for savings by outsourcing both positions and products. This presents senior defense officials with a dual challenge: First, what should the Department of Defense (DoD) make itself and what should it buy in the marketplace?⁴ Second, if the decision is to buy (or outsource), how can we ensure better outcomes for taxpayers?

A) The Make-or-buy Decision

The field of Transaction Cost Economics (TCE) offers an attractive theoretical foundation for business “make-or-buy?” decisions (Coase, 1937; Williamson, 1971, 1979; Alchian & Demsetz, 1972; Klein et al., 1978). These make-or-buy decisions ultimately define the boundaries of a company. Although primarily focused on the private sector the TCE literature has occasionally been applied in a government setting (Pint & Baldwin, 1997; Weingast & Marshall, 1988; Williamson, 1999; Ferris & Graddy 1986, 1991, Franck & Melese, 2005).

The dual objective of this section is to synthesize key principles and insights of TCE, and to apply those insights to support the “make-or-buy?” decisions of senior leadership in the Department of Defense (DoD). These make-or-buy decisions ultimately define DoD boundaries. In the course of this investigation, new tools will be revealed for Program Managers and others in the acquisition community to help govern contracting choices and to ensure better outcomes in terms of performance, cost and schedules.

B) Production and Transaction Costs

Coase (1937) was the first to ask why some profit maximizing firms produce goods and services themselves at higher production costs than can be purchased in the marketplace.⁵ The answer is that going to market entails “transaction costs,” and that these

⁴ In this study, the term “outsourcing” is used to encompass any situation that involves a government evaluation of whether to (continue to) produce a publicly provided good, service, or intermediate product or activity internally, or to purchase it from the private sector. An underlying assumption is that a decision has previously been made—presumably through a democratic process—for government to *provide* the good or service. The outsourcing evaluation determines whether the current government supplier, another government entity, or the private sector is best suited to *produce* it—or any necessary intermediate products or activities. The US Navy uses the term “strategic sourcing,” the US Air Force “competitive sourcing” (the British call it “market testing”). Office of Management and Budget (OMB) Circular A-76 spells out rules and procedures that govern outsourcing at the federal level. In the context of this paper, “privatization” can be interpreted as the outcome of an outsourcing evaluation where it has been decided the private sector will take over public assets to *produce* the good, service, or intermediate product, and where (in many cases) the government also relinquishes its role to *provide* it.

⁵ Today, businesses tend to restrict production to their core competencies and acquire the other parts of their products from outside suppliers. For example, one might expect an automobile manufacturer to accomplish the final assembly of the cars it sells, but acquire tires from outside companies. Less obvious is the case of a windshield.

search, information, decision, contracting, measurement, monitoring, and enforcement costs can more than offset production cost advantages from outsourcing.⁶

TCE views organizations as a complex web of contractual relationships among resource owners. Each relationship—the acquisition of an input, employment of a worker, transfer of a product or service from a supplier to a customer—is a transaction. In TCE, the transaction is the basic unit of analysis. The primary insight of TCE is that the choice of optimal governance mechanism (contracts, organizations, incentives) depends on key characteristics of the transaction (asset specificity, uncertainty, complexity, and frequency—each of which are discussed in this study).

In business, two costs typically drive the “make-or-buy?” decision: production costs and the costs of managing transactions or “transaction costs.” Conventional economic analysis focuses on production costs (input costs, competition, learning curves, economies of scale and scope, etc.). The new field of TCE emphasizes transaction costs (search and information costs, decision and contracting costs, monitoring and enforcement costs, etc.).

One of the most critical contributions of TCE is to focus on the nontrivial costs of managing and coordinating transactions. For example, consider DoD’s Defense Contract Management Agency (DCMA). This \$1.1 billion organization is made up of 10,500 Civilians and 600 Military whose exclusive responsibility is to help manage and coordinate some 300,000 defense contracts valued at nearly \$950 billion.

For a given product or service, the decision whether to “make or buy?” requires minimizing the sum of production and transaction costs. According to TCE, the dual focus of any outsourcing evaluation should be: a) to sort transactions into categories based upon certain key transaction characteristics, and b) to evaluate the costs and consequences of alternative contracts, organizational structures and mechanisms available to govern those transactions. Strategic contracting tools and other governance mechanisms can be applied to lower transaction costs. The lower the transaction costs of outsourcing, the smaller production cost savings need to be to support the decision to outsource.

C) The Challenges of Coordination and Motivation

Two key components of the “make-or-buy?” decision are highlighted in TCE: coordination and motivation. The issue of coordination arises from the economic opportunity for specialization and exchange. Organizations tend to specialize in “core” (inherently governmental) activities in which they have a comparative advantage, and engage in transactions (or outsource) to acquire other resources (e.g., contract labor), intermediate goods (material supplies, equipment, platforms, etc.), or services (IT, building maintenance, etc.). Transactions between government and industry can generate substantial gains for both parties. In DoD, the gains from specialization and exchange (outsourcing) are expected to take the form of more and better products, delivered more quickly, and with fewer resources (i.e., performance, schedule, and cost).

TCE recognizes these potential gains, but also acknowledges the dark side of transactions—motivation. TCE predicts parties involved in a transaction can benefit from

⁶ To use a physical analog, the market is not a frictionless medium. Operations in the marketplace require expenditure of time, resources, and management attention.



cooperative agreements, but since they are assumed to be self-interested and to have conflicting objectives, they will not always have the motivation to follow through on agreements—particularly when specific assets/investments are involved, and information is imperfect (incomplete and uncertain) or asymmetric (one party has an information advantage over the other). The ultimate outcome depends on specific characteristics of the transaction and on the incentive structures that govern the parties involved.

D) Limits to Government as an Enterprise

The concepts of TCE also hold inside the government. Coase (1937) and others contend “the operation of the market costs something and by forming an organization and allowing some authority to direct resources, certain [transaction] costs are saved” (p. 392). But the cure—integrating transactions inside the government—can be worse than the disease. When price and contract mechanisms are supplanted by internal coordination, this entails risks of sub-optimization, internal opportunistic behavior, multi-tasking, as well as internal bureaucratic costs of coordinating, monitoring and improving the cost and quality of publicly produced goods and services.

For example, consider the conflicting objectives and incentives that face major players in defense acquisition. The recently released Kadish report raises serious concerns about the ability of the Defense Acquisition System to “develop and deliver required capabilities when needed and at predictable [production] costs” (Kadish et al., Dec. 2005, “Defense Acquisition Performance Assessment, for the Acting Deputy Secretary of Defense,” p.1). The authors point to three key challenges: 1) “Requirements developers mandate systems that are technologically unrealistic or unable to be delivered within the ‘time-to-need’ that is desired by Combatant Commanders;” 2) “Program management teams allow requirements to escalate without discipline, driving costs beyond baseline budget and schedule;” and 3) “Those who hold the budget purse strings in DoD [...] reduce annual program budgets to fit within the “top-line” of the President’s Budget by trading-off some programs to ‘fix’ others” (p. 7). Prendergast (1999) provides a valuable overview of principal-agent models that highlight the costs and consequences of various incentive mechanisms designed to address internal coordination and motivation issues.⁷

In TCE, the successful resolution of resource allocation problems rests on designing mechanisms (incentives, organizations, markets, contracts, etc.) that allow opportunistic individuals with conflicting objectives to overcome their collective action problems in pursuit of mutual gains (Williamson & Masten, 1999). In the case of government outsourcing, TCE assumes government “principals” and industry “agents” each behave according to their conflicting interests. The objective of the DoD “principal” in outsourcing is to obtain goods and services better, faster, cheaper. Meanwhile, industry “agents” must guarantee market returns to shareholders (or maximize profits) to survive. The challenge is to arrive at governance structures that align the interests of both participants in the transaction.

⁷ An important distinction is made in the literature between complete and incomplete contract theory. Under complete contracting, all payments and actions can be specified ex-ante. The contracting parties can (costlessly) write contracts that describe their actions given all future contingencies. In contrast, under incomplete contracting due to information costs, bounded rationality, asset specificity, etc., some contingencies are left out of contracts, or, if included, might not be enforceable. Incomplete contracting thus implies some actions and payments will have to be determined ex-post, requiring adaptation and renegotiation. Complete contracting theory has developed through principal-agent models such as those reviewed in Prendergast (1999).

E) The “Principal-Agent” Model

TCE assumes that economic actors—say government “principals” and defense industry “agents” in an outsourcing relationship—are motivated to look ahead, recognize potential hazards, and factor these into contracts or organizational design. However, due to the problem of “bounded rationality,” so named by Nobel Prize winner Herb Simon, their capacity to do so is limited. Rubin (1990) puts it somewhat differently: “it is impossible to write a [complete] contract to protect a firm’s interests in a situation of complex contracting” (p. 26).

While parties to a transaction may jointly benefit from cooperation, they will not necessarily have incentives to live up to the terms of an incomplete contract and cannot expect others to do so (Williamson & Masten, 1999). The challenge is to design contracts, incentive schemes, monitoring and enforcement mechanisms, and to adopt other governance arrangements (property rights, reputation, bonding, warranties, etc.) that allow for credible commitments ex-ante and that promote mutual compliance ex-post (Williamson, 1983).

In game theory, the principal and the agent are both equipped with full knowledge of the set of actions the agent can engage in, and the principal fully knows those actions he/she is allowed to engage in. The principal is usually only ignorant about the precise effort level of the agent and the realization of an exogenous stochastic variable that impacts the output of the agent.

Instead of focusing exclusively on designing incentives to align the interests of the principal and the agent, Grossman and Hart (1986) and Hart and Moore (1989) address the perspective of incomplete contracting where bargaining problems can constrain efficient production. They demonstrate how the selective ownership of assets or property rights can alleviate many incentive and bargaining concerns. However, this approach to incomplete contracting assumes the outcome of the renegotiation process can be foreseen when contracts are written, and that the process does not involve costly bargaining. Tirole (1998) argues that clever mechanisms can be designed to handle unverifiable contract terms, returning the problem to one of complete contracting in the principal-agent tradition.

Here we take a broader-brush, stylized bargaining-game approach in the spirit of incomplete contracting. This approach is more closely aligned with the governance branch of TCE (Williamson & Masten 1999), where the main focus is on ex-post adaptation under incomplete contracting. In a model presented in Appendix A, the impact of costly ex-post bi-lateral bargaining and rent-seeking activity is explored when the outcome of renegotiation cannot entirely be foreseen.⁸

F) A Key Characteristic of Transactions: Asset Specificity

The specialization that takes place in certain transactions creates opportunities for enormous cost savings from productivity improvements, boosts in product performance, and tailored delivery schedules. These gains in cost, performance and schedules are frequently generated by investments in assets that are specific to the transaction. Thus, a vital TCE

⁸ Rent-seeking is the process of an individual seeking to profit from manipulation of the economic situation versus through trade and mutual benefit of the partners.

characteristic that defines many outsourcing transactions is the degree of asset specificity.⁹ Related to the notion of sunk costs, specific assets are investments made by parties to a transaction that lose much of their value in an alternative use. Examples include:

- Physical Asset Specificity—investments in specialized tools and equipment,
- Human Asset Specificity—investments in specialized skills, methods (government accounting), knowledge, training, etc.,
- Site Specificity—investments in location (of equipment, facilities, etc.) that economize on transportation or inventory costs,
- Dedicated Asset Specificity—investments in dedicated capacity and infrastructure (e.g., minimum efficient scale production facilities) for a particular customer,
- Brand-name Specificity—investments where the reputation of one party to the transaction depends on the actions/reputation of another (as with franchises, or public activities that represent and reflect the government), and
- Temporal Specificity—investments in “critical path” or bottleneck activities that can have enormous impacts on schedule completion costs and dates.

When specific assets are important and there are many competing suppliers bidding for an outsourcing transaction, it may at first appear that the market is competitive. However, Williamson (1999) points out that in many outsourcing transactions, “the winner of the original contract acquires a cost [or first mover] advantage (such as unique location or learning, including the acquisition of undisclosed or proprietary technical and managerial procedures and task-specific skills)” (p. 27). If the buyer (DoD) becomes dependent on a winning supplier that makes significant investments in specific assets (raising barriers to entry and the costs of switching to alternative suppliers), then ex-ante competition can yield to an ex-post buyer-seller bilateral monopoly situation. Rubin (1990) refers to this as the “fundamental transformation.”¹⁰

⁹ A crude measure of the degree of asset specificity is to take the cost of the initial investment and subtract any depreciation (physical wear and tear and obsolescence) and the salvage (or current market) value. Transaction Cost Economics (TCE) emphasizes that if the value of such transaction-specific assets is substantially lower in alternative uses (analogous to sunk costs), a “Holdup” problem can arise that limits specific investments, and consequently, the gains from specialization and exchange (or outsourcing).

¹⁰ Several demonstrative cases come to the minds of the authors, such as the Army Tactical Missile System (ATACMS) development contract being awarded to the developer of the vehicle platform. And innumerable production contracts have been similarly been awarded to prime system developers. However, one way to address the Holdup concern is with the strategic use of production options in a developmental project. Such was the case when in 1990, LTV Corporation had responded to the Army with “not-to-exceed” missile production costs as part of their proposal for a fixed-price development contract for missile and launcher integration. The options proposed had an expiration date. So the government was incentivized to fund the program and accomplish program decisions before expiration, while the contractor was motivated to seek cost savings in order to maximize profits under an eventual production scenario. The options were, in fact, exercised with only a few days to spare, and just in time to produce missiles employed during the first Gulf War.

G) The “Holdup” Problem

In TCE, the combination of transaction-specific investments and an absence of ex-post competition raises the possibility of a “holdup.” The “foot-in-the-door” strategy adopted by some defense contractors offers an example. In that case, a low bid induces the government to hire the contractor, but the contractor anticipates that as it works closely with the government, and as it makes specific investments that facilitate that relationship (e.g., human and physical asset specificity), the government will become increasingly dependent on that contractor.

For instance, since research and development contracts are necessarily incomplete and unexpected requirements often arise, a contractor might anticipate higher returns from later “holding up” the government by raising the price for “change orders” (changes in the contract).¹¹ Alternatively, the government has the power to hold up the firm by threatening to “walk away” from the relationship—say if demand for the product or service falls due to changes in the political or defense environment.

If individuals, firms, or organizations cannot be assured of realizing the full value of a transaction-specific investment through a credible commitment not to partake in post-contractual opportunistic behavior, then efficient productivity-, schedule- or performance-enhancing specific investments might not be made. In turn, this reduces both the surplus generated from a transaction and the incentive for parties to engage in that transaction.

The holdup problem arises whenever any party to a contract that involves a specific asset worries that after it has sunk an investment, it may be forced to accept worse terms ex-post, or that its investment might somehow be devalued by its contracting partner. Asset specificity lies at the core of the holdup problem, particularly in the case of complex and uncertain transactions that lead to incomplete contracting.

One concern is that the party that has less invested in the transaction may attempt to expropriate some of the value of its partner’s specific investment(s) through ex-post bargaining—say by threatening to walk away from the relationship. Thus, asset specificity makes asset owners vulnerable to “free-riding” by their contracting partners.

For example, while on one hand, the Kadish Report (2005) talks about the challenge of “motivating industry investments in future technology [and] encouraging industrial investment in areas of importance to the Department” (p.14), on the other hand it observes that government cost (budget cuts) and schedule (stretching out programs) instability has been a problem in all system acquisitions since the Civil War. As a consequence, transactions that require a significant degree of specific investments normally also require contracts and governance structures that protect the investor against early termination or opportunistic ex-post renegotiation.

¹¹ Demsetz (1968), Stigler (1968) and Posner (1972) suggest repeated bidding as a means to prevent ex-post opportunism in the case of government’s outsourcing a (regulated) natural monopoly. However, Williamson (1985, Chap 13) emphasizes that *switching costs*—related to specific investments—pose a hazard associated with government’s use of repeated bidding to outsource a natural monopoly. Once two parties have traded, switching costs may increase due to specific training/experience and other investments in transaction-specific assets, such that staying together can yield a surplus relative to trading with other parties.

The added risk faced by military contractors subject to political and budgetary uncertainty tends to dampen their enthusiasm for defense-specific investments. For example, Air Force sources indicate that, in early production stages, faced with uncertainty about the ultimate production run of the F-16, General Dynamics refused to make specific investments in the tooling and equipment required to automate riveting to reduce costs. As a result, the wings of these high-tech aircraft were initially riveted by hand. According to Kadish et al. (2005), while the “defense acquisition process [...] requires extended planning horizons, the Department’s budgeting process is based on short-term decision making” (p. 6). The outcome is “government-induced instability.” The report proposes a new governance structure to mitigate this uncertainty and add stability to major defense acquisition programs—an “Acquisition Stabilization Account.”¹²

H) Solutions to the “Holdup” Problem

The government can overcome incentives for contractors to under-invest in specific assets—for example, to adopt labor-intensive as opposed to more efficient capital-intensive production choices (with consequent higher prices)—by shifting the risk away from contractors. The risk to contractors can perhaps be reduced through stabilization accounts, or through contractual means by introducing contingent clauses that reward these investments through incentive contracts. Solving the asset-specificity problem can also be accomplished—and the risk to contractors eliminated—simply by shifting the ownership of strategic assets to the government. This “property rights” approach is discussed in Grossman and Hart (1986), and Hart (1995). In DoD facilities, for example, government ownership of specific assets is known as “Government Owned, Contractor Operated” (GOCO).

In the extreme, the government might choose to internalize the entire transaction (vertical integration), or to make rather than buy (as in Government Owned, Government Operated—GOGO facilities). The optimum choice for DoD (COCO, GOCO or GOGO) ultimately depends on an evaluation of production and transaction costs, product performance, and schedule and delivery options.¹³

I) Alternative Governance Structures

TCE recognizes that transactions can be organized under a spectrum of governance structures ranging from spot markets to vertical integration. Between these two poles are contracts of increasing duration and complexity—from Fixed Price (FP) to Cost Plus (C+), and from simple short-term contracts, to incentive, long-term, and relational contracts

¹² Another example comes from an author’s experience in the Javelin anti-tank missile program, wherein the procurement objective was halved as the product entered production. This resulted in a change to the production strategy to split a joint venture into two producers—retaining vertical integration.

¹³ The government might also retain some in-house (perhaps standby) capability to provide the good or service in question (known as “tapered integration.”). This, and similar measures, could enhance the DoD’s bargaining position in the event of renegotiation or contract-enforcement actions. Changing the ownership of assets associated with relation-specific investments can also reduce the scope for opportunistic behavior. This can take the form of government-furnished equipment in defense transactions (GOCO). However, such hedging measures entail costs that can dissipate the potential gains from outsourcing.

(McAfee & McMillan, 1988). Outsourcing involves a move away from vertical integration to spot market transactions or one of the intermediate or “hybrid” contracting options.¹⁴

According to Williamson (1999), three key attributes differentiate governance structures: 1) incentives, 2) administrative controls, and 3) dispute settlement (or adaptation). Spot market purchases are characterized by high-powered incentives, little administrative control and a legalistic dispute settling mechanism. Unfortunately, while market governance provides strong, high-powered incentives for quality and cost, it offers little protection for specific investments since buyers and sellers can easily walk away from transactions. Thus, the transaction costs of dealing with markets increases with the potential for holdups. In contrast, whereas vertical integration (organic production) alleviates holdups since dispute settlement takes place largely within the organization, it combines low-powered incentives with extensive administrative (bureaucratic) controls.

A path-breaking econometric study (Masten et al. 1991) based on the procurement of components and services by a large naval shipbuilder indicates overall organization costs represent about 14% of total costs for components and activities in the sample. More importantly, “these costs vary systematically with the nature of the transaction and [...] savings from choosing organizational arrangements selectively can be substantial.” Interestingly, the authors find that “subcontracting work currently performed inside [...] would, on average, generate market organization costs almost three times those incurred managing that work internally,” and that as “the costs of dealing across a market interface [...] rise the greater the potential for holdups in a given transaction [...]” (p. 2). Of course, adopting new technology like the Internet and leveraging the falling cost of computer and communications equipment can reduce the “costs of dealing across a market interface.”

Short of vertical integration (in-house production), contracts, strategic alliances, partnerships, joint ventures, etc., can be designed to provide some protection for assets while still preserving market incentives. The challenge is that the benefits from the transaction be divided in such a way that they induce the efficient amount of specific investment(s) in the contracting relationship. This involves writing a contract with enough precision to assure desired performance, but with enough flexibility to allow productive adaptation, as circumstances require. The challenge increases the greater the degree of asset specificity and the more complex and uncertain the transaction.

Combined with bounded rationality, imperfect information tends to preclude comprehensive ex-ante contracting, making many contracts inherently incomplete. In turn, this raises the opportunity for holdups and ex-post renegotiation. In summary, TCE predicts the higher the degree of asset specificity, the greater the likelihood that vertical integration, longer-term contracts, and other mechanisms (reputation, GOCO, etc.) will be used to promote and protect transaction-specific investments.

¹⁴ Note that the recent wave of mergers and acquisitions that emphasized vertical integration in the US may finally be giving way to the so-called virtual corporation. It appears strategic outsourcing through contracts, partnerships, alliances, and joint ventures may be redefining organizational boundaries over the next decade (Michaels, 2001).

J) Some Empirical Evidence

On the whole, the results of the empirical literature are consistent with these theoretical predictions. In the case of vertical integration, Monteverde and Teece (1982a) found automobile components that required greater design engineering (human asset specificity) were more likely to be vertically integrated (or less likely to be outsourced).¹⁵ Moreover, according to the Masten et al. (1991) study of subcontracting practices in naval construction, the probability of vertical integration increased with the temporal specificity of particular construction activities. This is because any delay in these key critical path activities would disrupt the overall completion time of the project. If such a product was outsourced instead of vertically integrated, subcontractors could threaten a delay (holdup) in exchange for price concessions (increasing transaction costs). Reputation is another important enforcement mechanism that can be used to alleviate this problem, especially in the case of repeated relationships.¹⁶ We'll observe in Section 3 that "past performance" is used as a criteria for subsequent contract awards, revealing that reputation is indeed a mechanism used to encourage specific investments and avoid holdups in practice.

There is evidence that longer term contracts are used as a mechanism to mitigate the risk of holdup between coal mines and electric utilities that involve greater levels of asset specificity. Joskow (1987) examines transactions between coal mines (sellers) and electric utilities (buyers). The study reveals two interesting cases. In the West—where there are few coal mines, more limited transportation, and different grades of coal—there is a higher degree of asset specificity associated with transactions, and greater threat of ex-post opportunism. As predicted by TCE, Joskow reports transactions in the West tend to be governed by longer-term contracts, and that spot markets are virtually non-existent.¹⁷

In sharp contrast, in the Eastern United States—where there are many electric utilities and coal mines, abundant and competitive transportation, and coal is largely homogeneous—there is a lower degree of asset specificity associated with transactions, and consequently a smaller threat of ex-post opportunism. As predicted by TCE, Joskow reports transactions largely occur in spot markets governed by short-term contracts.

With respect to other mechanisms that can help promote and protect physical asset specificity—such as Government Owned, Contractor Operated (GOCO) specific assets—Monteverde and Teece (1982b) found automobile manufacturers were more likely to own

¹⁵ A specific example comes from the decision of prime system developer Texas Instruments to make their own critical component of the Javelin anti-tank missile system: the matrix focal plane array. This item became the pacing item in the entire program—leading to a holdup situation—and eventually had to be outsourced to another vendor.

¹⁶ For example, Acheson (1985) found that in fish markets, given a price for a catch, buyers (sellers) could act opportunistically by sorting individual high-quality (low-quality) fish. Monitoring could be used to avoid this, but increases transaction costs and lowers the surplus enjoyed by both parties. Instead, informal reputation-based agreements served to avoid these extra costs.

¹⁷ Moreover, Joskow (1985) reports that when electricity plants locate themselves near coal mines to avoid high transportation costs (site specificity), they must be tailored to the grade of coal (physical asset specificity). As TCE predicts, the measures of vertical integration and explicit long-term contracts are common. In fact, these so-called "mine-mouth plants" were six times more likely to own the associated mine than other electricity generators. Those contracts are typically twenty to fifty years in duration, with provisions that prohibit price renegotiation for extended periods, specify in detail quantities to be supplied over the period, specify the quality of coal, index costs and the prices of substitutes, and defined procedures for arbitration in the event of disputes.

the tooling used by their suppliers, the more specialized and expensive it was. Moreover, according to Klein et al. (1978), General Motors' decision to acquire (or vertically integrate) Fisher Body was partly influenced by the need for transaction-specific investments in new stamping presses and dies (physical asset specificity). (The Fisher Body story has become a matter of some controversy.¹⁸)

Finally, an important lesson is that government must commit not to expropriate assets from contractors or regulated firms if it wants them to invest in transaction-specific assets. Levy and Spiller's (1994) international comparison of telecommunications regulation demonstrates that only if regulators commit not to pursue arbitrary administrative actions that threaten the value of specific assets, will private (specific) investment be forthcoming. For instance, where regulators failed to commit not to set arbitrarily low prices, regulated firms were unwilling to make specific infrastructure investments because they feared they might not be able to recover the value of those investments.

K) Other TCE Characteristics: Complexity, Uncertainty and Frequency

Besides asset specificity, transactions are also characterized by complexity and uncertainty. Crocker and Masten (1988) address the impact of uncertainty on contract duration. They find that government's regulation of the price of natural gas, in reducing the ability of parties to adapt long-term contracts to reflect future uncertainty, reduced contract lengths in the industry by an average of 14 years.¹⁹ The greater the uncertainty, the shorter was the duration of the contract.

A study by Bajari and Tadelis (1999) on construction contracts provides evidence that complexity and uncertainty are sufficient to generate ex-post adaptation and renegotiation—even in the absence of specific investments. It turns out that the decision to govern construction transactions with Fixed Price (FP) type contracts, as opposed to Cost Plus (C+) type contracts, is sensitive to the complexity and uncertainty in the transaction. Interestingly, a counterpart to this example exists in governance options prescribed by the US military for outsourcing various phases in a new product's development (see Table 1 below).

Evidence uncovered by Bajari and Tadelis (1999) reveals that in cases where a construction transaction is easy to define and measure—i.e., there is little complexity, and only a few minor changes are expected, there is little uncertainty and FP contracts tend to dominate. However, the more complex and uncertain the transaction (and the more difficult and costly it is to define and measure performance) the more likely a change in the contract will be required, and the more severe the adversarial relationships experienced ex-post when FP contracts were chosen.

In the latter case, FP type contracts often ended in costly renegotiations where any surplus generated in the transaction was dissipated in the course of negotiations through

¹⁸ Coase (2000), Casadesus-Masanell and Spulber (2000) regard the standard story as a "fable," flawed in both fact and interpretation. Freeland (2000) goes further and contends that vertical integration made General Motors *more* vulnerable to rent-seeking behavior. However, a rejoinder from Klein (2000) defends the 1978 analysis cited above.

¹⁹ Moreover, uncertainty caused by the 1973 oil embargo reduced contract lengths by another three years.

unproductive bargaining and influence activities. Thus, even in the absence of asset specificity, complexity and uncertainty can force parties to turn to C+ type contracts and to rely heavily on reputation and other enforcement mechanisms to avoid ex-post opportunistic behavior that can dissipate the surplus (or value) generated by a transaction.

Relating these observations to military outsourcing for major weapon systems, empirical evidence uncovered by Crocker and Reynolds (1993) for the manufacture of US Air Force aircraft engines mirror the findings in Bajari and Tadelis (1999). In the initial production stages—when modifications were expected—contracts that governed transactions tended to be of the cost reimbursement variety (C+). In later production stages—after initial problems had been ironed out—contracts tended to be of the fixed price variety (FP). Of course, this kind of selection of contract type has become a matter of well-known policy. For purposes of illustration, Table 1 summarizes prescribed contract types employed by the US Air Force and Navy at each stage of development of a new product (Federal Acquisition Institute, 1998).

Table 1. Stages of Product Development and Contract Types

Stages of Product Development	Basic Research	Exploratory Development	Test & Demonstration	Full-Scale Development	Production	Follow-on Production & Spares
Contract Specification (PWS)	Not Well-Defined (C+) ←————→				Well-Defined (FP)	
Contract Type (see list below)	C+I	C+I, C+FF	C+I, FPIF	C+I, FP, FPI	FP, FPI, FPEPA	FP, FPI, FPPR
Gov't Cost Risk	High ←————→				Low	

1. Fixed Price Contracts (FP)

- a. FP—Fixed Price: Ex-ante negotiated contract price is not subject to any adjustment based on actual ex-post costs of performing the contract.
- b. FPI—Fixed Price plus Incentive Fee: Contract provides for incentive based on pre-determined share of actual costs (profits) over (under) target costs (profits), or based on subjective measures of performance against standards. Firm ceiling price limits overall payments.
- c. FPEPA—Fixed Price with Economic Price Adjustment: Contract provides for price adjustments to reflect exogenous cost increases/decreases.
- d. FPPR—Fixed Price with Prospective Re-determination: Contract provides fixed price for first period and timetable for re-pricing over subsequent periods.

2. Cost Reimbursement Contracts (C+)

- a. C+FF—Cost-plus-fixed fee: Contract pays allowable costs plus fixed fee (If $FF=0$ then same as Time & Materials, If $FF<0$, then Cost Sharing between government and contractor).
- b. C+I—Cost-plus-incentive fee: Contract pays allowable costs plus incentive fee based on assessments of performance (such as actual costs and delivery dates, and/or more subjective measures).

Table 1 indicates FP (C+) type contracts are prescribed in later (earlier) stages of product development when complexity and uncertainty have (have not) been resolved, and the Performance Work Statement (PWS) is well (not well) defined, and that this results in relatively low (high) risks to the Government. Note that while these prescribed contracts focus on the characteristics of complexity and uncertainty, apparently overlooked is the vital role of asset specificity—one of the key insights of TCE.

Another significant characteristic of transactions is frequency. Recurrent transactions often justify the setup costs of specialized assets and special governance requirements. They also offer the opportunity to apply learning curves (cumulative cost-quantity relationships) to lower production costs, and for gradual reductions in uncertainty as both parties learn more about costs. Recurring transactions also offer the possibility for the accumulation of goodwill and to build reputations. In summary, TCE emphasizes four key characteristics of transactions: asset specificity, complexity, uncertainty, and frequency.²⁰

L) Solving Governance Problems through Vertical Integration

When asset specificity, bounded rationality (complexity and uncertainty), and opportunism make contracting problems too difficult (or external transaction costs too high), “the problems of incomplete contracting are often relieved by unified ownership” (Williamson, 1999).²¹ But when transactions occur within an organization, calculations must

²⁰ For purposes of illustration, consider two polar examples: A transaction that involves routine aircraft maintenance and one that involves defense Research & Development (R&D) on a major weapon system. In the case of recurring purchases of routine maintenance, the service is relatively homogeneous, not especially complex, and, therefore, can be well specified. Assuming there are mild information asymmetries and many competing suppliers employing mostly non-specific assets, market governance can be prescribed to minimize both production and transaction costs. Anytime competition exists among suppliers of well-specified homogeneous products, spot market purchases or simple FP contracts generally offer adequate governance structures to induce cooperative adaptation and minimize transaction costs. If government performs such functions, then public-private competitions are likely to reveal both production and transaction cost savings from outsourcing. In sharp contrast, a complex, nonrecurring defense R&D program involves challenges in specifying the product, service, or project as well as significant technical uncertainty over the results. Moreover, even if the R&D contract is let through ex-ante competitive bidding, “holdup” problems due to asset specificity may present significant cost control and ex-post bilateral dependency hazards.

²¹ If such agreements turn out to be too costly to implement and enforce—or “maladaptation hazards” are too great—then outsourcing can give way to insourcing (or vertical integration) (Williamson, 1999). An important result of TCE is that internalizing transactions can reduce customer and provider incentives to engage in opportunistic behavior, and promotes the sharing of specialized information. Internalizing some activities under the direct control of a manager can economize on transaction costs, and (together with production cost considerations) these cost savings provide an efficiency basis for defining the boundaries of an organization. The main value of ownership integration is that it reduces buyer and seller incentives to engage in opportunistic behavior and promotes the sharing of specialized information. The choice of governance structure for any transaction—either insourcing (or vertical integration), or outsourcing (or spot market purchases)—depends upon both *production* and *transaction* costs.

also include the costs of internal coordination and motivation. Whereas vertical integration brings transaction-specific assets under the control of one organization and reduces opportunism from holdup, hierarchies can't control costs as effectively as markets—or suffer from “low-powered” incentives. Moreover, bounded rationality limits the span of effective internal managerial control, so that lower-level managers and employees often engage in multitasking, sub-optimizing, and unproductive rent-seeking behavior (Prendergast, 1999).

Hierarchy in a government organization can lead to legitimate sub-optimization, where the joint pursuit of lower-level goals fails to coincide with the global objectives of the organization.²² This often happens in the budget planning process with internal lobbying for resources. However, opportunism can compound the problem by introducing strategic efforts to gain local advantage at the expense of the larger group. Sub-optimization can thus expand to include the strategic use of asymmetric information for local benefit. As a consequence, while government in-sourcing can reduce ex-post opportunism due to holdup, the tradeoff includes: a) low-powered incentives, b) internal opportunistic behavior, and c) an increase in administrative costs.²³

Anytime ex-ante competition among suppliers is transformed into an ex-post bilaterally dependent relationship, additional governance structures are required to induce cooperative adaptation.²⁴ These structures can include anything from agreements to share and verify cost and performance information in incentive contracts to the careful crafting of dispute settlement mechanisms. However, such agreements often increase external transaction costs. The higher external transaction costs, the larger production cost savings need to be to support the decision to outsource. An underlying objective of TCE is to

²² A further complication (but beyond the scope of this discussion) is employee goals not congruent with the government's. This includes the strength of incentives for efficient operation. Why, for example, should a contracting officer who is spending public funds (and not his own) be more diligent in monitoring performance when dealing with outside contractors than “in-house” supervisors are in dealing with internal procurement?

²³ Wintrobe (1977) offers a good review of the literature that analyzes the strategic behavior of a public monopolistic, budget-maximizing bureau—or internal agent (Niskanen, 1971), that can make take-it-or-leave-it budget proposals, and its sponsor—or internal principal. Mueller (1989) later replaces the assumption the bureau is allowed to make take-it-or-leave-it budget proposals with a model in which the sponsor chooses a desired level of output based on the bureau's announced price per unit of output. Claar (1998) expands the role of the sponsor to regulate the bureau by allowing it to select both the level of output and the allowed price per unit, based on the bureau's reported marginal cost. Adapting Baron and Myerson's (1982) incentive compatibility framework for regulating a monopolist with unknown costs to the sponsor's problem of monitoring a bureau with unknown costs, the welfare-maximizing pricing policy deviates from the standard efficient pricing policy, $P=MC$. The deviation of the optimal pricing policy from the usual $P=MC$ pricing rule arises due to asymmetric information—or the informational advantage the bureau has concerning its own costs. Internal transaction costs must, therefore, include a subsidy paid by the sponsor in addition to MC to induce the bureau to report its costs truthfully. Baron and Besanko (1984) modify the Baron-Myerson model to permit the regulator to conduct random audits of costs. This introduces an additional transaction cost—monitoring costs. These examples point to the internal transaction costs (a subsidy to induce truthful reporting or monitoring costs to establish correct costs) that must be weighed against any production cost advantages that might exist from insourcing or internalizing transactions in government's *make or buy* decisions.

²⁴ According to Williamson and Masten (1999), the “central problem of economic organization is adaptation” (p. xi). The challenge of adaptation is especially acute when ex-ante competition leads to ex-post monopoly power. Whenever products, services or projects cannot be well specified in advance (due to complexity, uncertainty about future conditions, measurement difficulties, etc.), and they involve transaction-specific assets, then ex-ante competition (e.g., competitive bidding) can lead to ex-post monopoly/monopsony power. In turn, this leads to costly adaptation through bilateral bargaining and renegotiation.

contribute to the design of contracts, organizations, and other governance structures to reduce transaction costs and improve the gains from exchange.

M) A Case Study: Competitive Sourcing and OMB A-76

Outsourcing relationships vary widely in their characteristics (asset specificity, uncertainty, complexity, frequency, etc.) and potential difficulties. As a consequence, increases in transaction costs (required to govern an outsourcing relationship) can more than offset any production cost advantages from outsourcing. Outsourcing relationships can involve extra transaction costs such as measurement, monitoring, and negotiation costs that can quickly overwhelm a simple 10% production cost advantage.

Another crucial insight of transaction cost analysis is that different ex-ante contracts offer different incentives for unproductive ex-post bargaining and influence activities.

If the performance work statement (PWS) describing the desired product, service or project can be specified precisely as an Invitation for Bid (IFB), and there are no transaction-specific assets involved, then FP type contracts have the benefit of creating cost-reducing incentives that reward the buyer through ex-ante competition between potential suppliers. In this case, FP contracting increases contractor incentives to invest in cost reduction, and ex-ante competition can transfer these cost-savings directly to the buyer.

In contrast, if the PWS cannot be specified precisely such that there is a Request for Proposal (RFP), and/or if there are significant specific assets involved in the transaction, then some surplus will be eroded by the frictions of ex-post negotiation. This loss from bargaining activity is part of the cost of using a FP contract in this case. The more complex and uncertain the transaction, the less complete the PWS, the greater the cost in using FP, and the more attractive other contracting options become.²⁵

However, Bajari and Tadelis (1999) (citing Ashley & Workman, 1986) demonstrate that providing cost incentives in a contract is more likely to lead to disagreements and spoiled relationships and ex-post friction in interpreting the outcomes. In fact, avoiding these frictions and reducing the advantages to renegotiation can be accomplished by investing in a more complete PWS, and by adopting alternative mechanisms (reputation, etc.) to reduce the return from opportunistic bargaining behavior.

TCE suggests that the degree of completeness of the PWS and the contract is an optimizing decision by both parties that reflects their trade-offs between an ex-ante investment in the PWS and contract design, and the potential ex-post cost of opportunistic bargaining and renegotiation. Moreover, since the principal insight of TCE is that the choice of optimal governance structure depends on the characteristics of the transaction, the dual focus of any outsourcing evaluation should be: a) to sort transactions into categories based on their principal characteristics (asset specificity, uncertainty, complexity, and frequency), and b) to evaluate the costs and consequences of alternative contracts, organizational structures and mechanisms available to govern those transactions.

²⁵ This might best be illustrated with the A-12 advanced stealth bomber aircraft program: an example of false security from government risk placed in a fixed-price type of contract chosen for a large complex development contract, the result of the project being costly for both parties on a grand scale (Stevenson, 2001).



N) Results from a Bargaining-game Model of Transactions

A fundamental insight of TCE is the importance of uncovering both production and transaction costs associated with the “make-or-buy?” decision. Here, comparative static results from a stylized bargaining game model developed in Appendix A are applied to the special case of public-private competitions regulated by OMB Circular A-76. This approach reveals characteristics of transactions that can be used to distinguish between two categories of internal government transactions: “good” as opposed to “more challenging” candidates for outsourcing.

According to the documents, five steps are required to conduct a public-private competition for an activity currently done by the government:

1. Develop a Performance Work Statement (PWS) to define performance and a Quality Assurance Surveillance Plan (QASP) to measure performance.
2. Construct a Most Efficient Organization (MEO) for the insourcing (in-house) cost estimate.
3. Prepare an Invitation for Bid (IFB) for well-defined, routine commercial activities, or a Request for Proposal (RFP) for ill-defined, complex, uncertain projects that involve specific assets.
4. Compare bids or proposals with the in-house estimate, and select a winner. In the case of an IFB, the concern is to minimize costs. In the case of an RFP, the concern is cost-effectiveness. In the case of an IFB, continue to in-source unless the government can obtain equivalent performance and threshold savings are above 10% of direct personnel costs or a cumulative \$10 million over the performance period. The same holds for the case of RFP, with the further possibility of outsourcing if it is judged significantly better performance can be achieved at the same cost as the MEO.
5. Address appeals.

O) Characteristics of Good Candidates for Outsourcing

Where a transaction requires little in the way of specific assets (no holdup problem), and involves a product or service that is a) well-defined and homogeneous (IFB), b) easy to measure (limited complexity and mild information asymmetry), c) routinely used (recurring/frequent purchases), d) not subject to change (limited demand uncertainty), and e) is offered by competing suppliers, then there is little room for negotiation (price and performance are market-driven), and the marginal benefit of unproductive bargaining is essentially zero. With little room for bargaining over such routine and uncomplicated transactions, substantial production and transaction cost savings can be expected from outsourcing, or from purchasing directly in spot markets (say over the Internet). (This can be seen directly from [3a,b] in Appendix A: since if $\sigma = 0$, then $b=0$).

Moreover, since administrative, incentive, and enforcement costs tend to be low for goods and services produced in competitive markets, the marginal cost of engaging in the



transaction is small, and the marginal cost of unproductive effort is high. This ratio encourages greater effort (e) and investment in the transaction and, ceteris paribus, tends to generate a larger surplus (S), or a higher return to outsourcing (See Appendix A).

In general, the less complex and uncertain a transaction, the easier it is to write an explicit contract that covers all relevant contingencies. Moreover, the lower the administrative and enforcement costs of that contract, the higher the expected marginal cost of ex-post bargaining or rent-seeking activity, and the lower the expected return from that activity. This reduces optimal ex-post bargaining (b), thus lowering transaction costs associated with outsourcing. The favorable characteristics of these so-called good candidates tend to encourage greater productive effort that in turn contributes to a larger surplus (value) enjoyed by both parties, increasing the returns from outsourcing.

P) Characteristics of More Challenging Candidates for Outsourcing

More challenging candidates include transactions that involve non-standard (differentiated) products or services that take place in a bilateral contractual setting. In this case, assuming no specific assets are required, the results (bargaining, b, effort, e, and surplus, S) depend on the degree of contractual ambiguity governing the transaction, as well as on any administrative and enforcement costs involved. However, as complexity, uncertainty, and opportunism due to specific investments increase, so does the marginal benefit of bargaining or ex-post renegotiation. This results in higher external transaction costs that need to be offset by more substantial production cost savings in order to justify outsourcing.

Productive investment (effort in the model) can be thought of as involving two types of assets: general and specific. The greater the ratio of specific assets to total investment, the greater the risk of “holdup.” Moreover, as the threat of bilateral dependency increases, the more incomplete the contract (and the lower the penalty for reneging or renegotiation), the lower the marginal cost to each party of engaging in unproductive bargaining or influence activities (i.e., the lower γ). In the face of incomplete contracting, the holdup problem poses a hazard Williamson calls “maladaptation.” Maladaptation is captured here as an increase in the return to both parties in unproductive bargaining (i.e., an increase in σ). From Appendix A, as σ increases and γ decreases, a greater amount of unproductive bargaining (b), and a lower productive effort or investment (e) can be expected, that will lower the surplus (S) enjoyed by both parties to the transaction.

Any time ex-ante competition among suppliers is transformed into an ex-post bilaterally dependent relationship, additional governance structures may be required to induce cooperative adaptation. The challenge is to write a contract with enough precision to encourage desired performance, but enough flexibility to allow productive adaptation (adjustments), as circumstances require. But in the case of complex transactions and uncertain outcomes, “bounded rationality” precludes comprehensive ex-ante contracting (contracts are inherently incomplete) which raises the possibility of gains from (unproductive) ex-post opportunistic bargaining and renegotiation (e.g., the “holdup” problem).

Contracting, therefore, offers an imperfect solution to opportunism. What are required are additional governance mechanisms (rules and regulations, reputation mechanisms, GOCO, etc.) to settle disputes and adapt to new conditions, and ex-ante

efforts to screen for reliability and reputation or to safeguard and protect transaction-specific investments (i.e., lowering the marginal return to bargaining, σ , and raising the marginal cost, γ). These structures can include anything from agreements to share and verify cost and performance information through incentive contracts, to the careful crafting of dispute settlement mechanisms. Appendix B offers a simple Stoplight scheme to help defense managers recognize key characteristics of transactions that could guide them to choose an appropriate contract type and governance mechanism to improve outcomes in terms of performance, cost and schedule.

SECTION 3: DEFENSE MATERIEL ACQUISITION

This section describes the current acquisition transactional environment and provides a synthesis of acquisition transaction components and their strata of governance, followed by an overview of associated management practices in the DoD.

A) The Transactional Environment

*The Defense Acquisition System exists to manage the nation's investments in technologies, programs, and product support necessary to achieve the National Security Strategy and support the United States Armed Forces. The investment strategy of the Department of Defense shall be postured to support not only today's force, but also the next force, and future forces beyond that. The **primary objective of defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission capability and operational support, in a timely manner, and at a fair and reasonable price.** (Department of Defense Directive 5000.1)*

“Acquisition” is the acquiring of supplies or services (including construction) by contract with appropriated funds by and for the use of the Federal Government through purchase or lease (FAR Part 2.101b). The realm of defense acquisition extends from the development and procurement of materiel, to purchasing services and sustaining support for our military. Government acquisition is unique as a public enterprise.

While many businesses and public agencies conduct internal product development for themselves and others (or conduct external projects for others), the Department of Defense, for the most part, commissions external suppliers to conduct projects for its internal use. In short, the DoD outsources much of what we consider to be “acquisition,” with all of the attendant transaction costs of search, information, decision, contracting, measurement, monitoring, and enforcement.

Defense developmental projects, and their later procurement, are often seen as among the most challenging acquisition endeavors, because of their large size and technological complexity. Such transactions are undertaken with contracts in the context of inter-firm collaboration: where a client firm engages an outside supplier to design and/or engineer a component, subsystem or process (Carson, Madhok, Vasrman & John, 2003). Unique also are the performance, quality and security requirements of materiel. The extremes of combat environments often place products and end-users at risk of physical harm, and any failures in performance, timeliness or cost can significantly impact national security.



The government's goal orientation in its development and procurement pursuits is provided in the guiding principles of the Federal Acquisition Regulation:

*The Federal Acquisition System will—(1) **Satisfy the customer in terms of cost, quality, and timeliness of the delivered product or service** by, for example—(i) Maximizing the use of commercial products and services; (ii) Using contractors who have a track record of successful past performance or who demonstrate a current superior ability to perform; and (iii) Promoting competition; (2) **Minimize administrative operating costs**; (3) Conduct business with integrity, fairness, and openness; and (4) Fulfill public policy objectives. (FAR, 2004, Part 1.102)*

This is in concert with the opening quote above from DoD Directive 5000.1, but goes a bit further by describing the desired nature of acquisition transactions. It can be assumed that there is often significant goal incongruence in public-private outsourcing relationships: the government seeks the best possible value of goods and services for the least cost to the taxpayer, while private industry typically seeks to maximize profit and avoid competition. But such fundamental goal differences notwithstanding, this buyer-seller partnership has historically yielded supreme American military capability, as well as profit for shareholders. Of course, the two questions often asked are whether we have purchased this capability at the best price, and whether the equipment, supplies and services get into the hands of our military in a timely manner.

B) Contracting and Project Management

Contracts are the governance mechanisms and transaction vehicles used to facilitate development or procurement expenditures. Guiding the choice of contracts is the Federal Acquisition Regulation (FAR) and its DoD supplement, the Defense Federal Acquisition Regulation Supplement (DFARS). The FAR consists of over 1900 pages that codify uniform policies and procedures for acquisition by all executive agencies of the US government. The DFARS adds over 1100 more pages of agency-specific policy and procedures to be followed by the Defense department in its contracts and purchases. Authority for the award and administration of government contracts is vested in warranted contracting officers. They typically reside in service-specific acquisition centers: organizations within larger “systems commands”^{*} usually organized by commodity item, such as communications and electronics, aviation, and armaments, etc.

The DoD uses project management techniques (GANTT Charts, Critical Path Methods, PERT, etc.) as a methodology to conduct its outsourced product development efforts, recognizing the unique and temporary nature of many projects. Project management provides for a single point of contact, the program manager, who is the major force directing systems through their evolution and lifecycle: including design, development, production, deployment, operations and support, and disposal. The program manager (PM) has management authority and accountability for all business and technical aspects of a specific program.

^{*} Also service Inventory Control Points and Defense Supply Centers.



Program Managers lead Program (Project or Product) Management Offices. Program Management Offices (PMOs) are part of the transaction costs of overseeing contracts. They provide the PM with further resources to manage the acquisition of materiel, supporting warfighters as end-users. Many members of the acquisition workforce furnish either core or matrix support to a PMO.

At the beginning of FY2000, the size of the DoD's acquisition workforce was estimated to be 124,000 personnel (ADR, 2000). The Defense industry's suppliers typically follow the project management methodology established by the PM, and often contractors will staff and operate their program offices to parallel that of the government programs they support. Both types of DoD managers, PMs and contracting officers, act as transaction agents to ensure that public funds are being used prudently to accomplish the mission, while also promoting public policy mandates (e.g., small and disadvantaged businesses), and ensuring that relevant Government regulations (e.g., safety) are enforced.

The DOD 5000 series of regulations serves as overarching guidance for the acquisition of materiel—primarily materiel requiring new development and subsequent investment in production. DOD Directive 5000.1, The Defense Acquisition System, provides policies and principles to govern the management of all DoD acquisition programs. There are five major thrusts governing the overall acquisition system: 1) flexibility in shaping individual programs to meet needs, 2) responsiveness in achieving capabilities in accord with their timelines of need, and doing so in increments via evolutionary acquisition, 3) innovation via practices that reduce cycle-time and cost, 4) discipline in the adherence to goals, with program baseline parameters serving as control measures, and 5) effective management through decentralized responsibility and authority (DODD 5000.1, 2003).

DoD Instruction 5000.2, Operation of the Defense Acquisition System, establishes a management framework that translates mission needs and technological opportunities into stable, affordable, and well-managed acquisition programs (DODI 5000.2, 2003). The instruction provides procedures for operation of the acquisition management system in conjunction with a system of prioritizing and allocating funds (the Planning Programming, Budgeting and Execution System (PPBES)), as well as a system to generate materiel requirements (the Joint Capabilities Integration Development System (JCIDS)). Together, they produce bonafide transaction needs, resources and technical performance solutions. The successful interaction of these three decision-support and management systems are the governance mechanisms relied on to produce advanced warfighting capability.

C) Cost, Schedule and Performance Attributes are Stratified

The first FAR principle stated above of customer satisfaction (including “cost, quality, and timeliness of the delivered product or service”) encompasses many of the key features of acquisition transactions. Acquisition transactions can largely be categorized by their timeliness, dollar value, and technical performance requirements and characteristics (which are translated into measures of project management success).

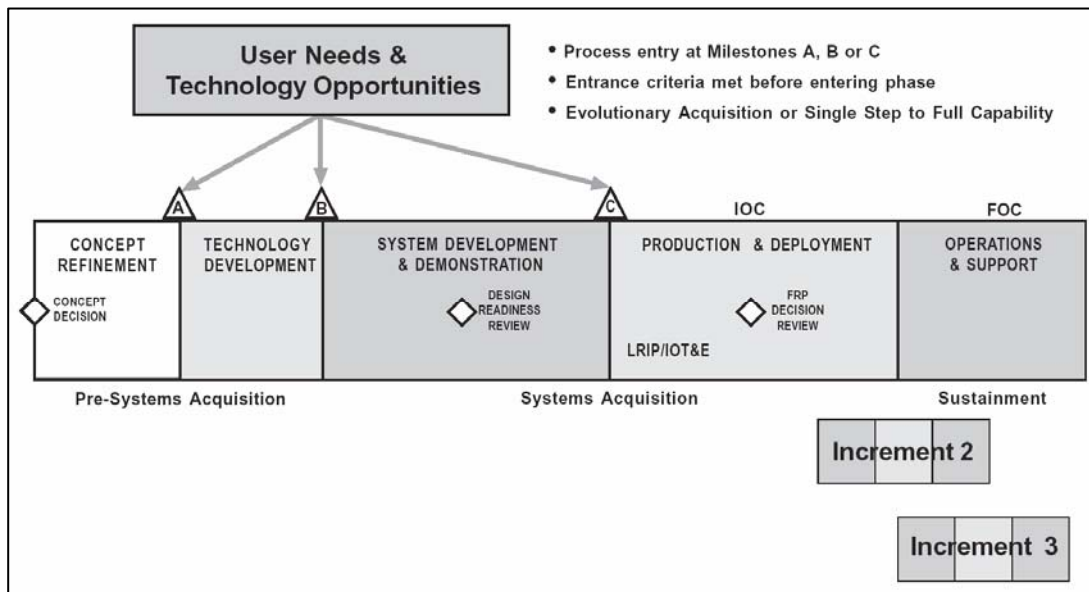
These characteristics are often identified and stratified in various policy and regulatory documents that affect acquisition procedures and governance. The TCE characteristics of uncertainty and complexity are largely incorporated within the parameters of cost, schedule, and performance. Asset specificity is not addressed per se; however, the DoD has long acknowledged the dangers of becoming “locked-in” to propriety technology (or unique expertise, i.e., human asset specificity) (DOD Guidebook, 2004). Interestingly, we observe much less of this cautionary language today, possibly because of highly inelastic



demand due to wars fought in Iraq and Afghanistan, or perhaps because the potential for “holdup” is simply being overlooked.

Material acquisition is often viewed as occurring over a *lifecycle*—moving from initial concepts to engineering and development, into production (procurement) and to operations and maintenance/support until eventual disposal. See Figure 1 below. This lifecycle involves a product’s maturation that tends to reduce uncertainty and complexity as the product is developed and fielded.

Figure 1. Defense Acquisition Decision Reviews and Phases



The funding comes from several different sources and involves different contracts. For developmental systems acquisition endeavors, the funding comes from the Research Development, Test and Evaluation (RDT&E). Procurement appropriations are used to acquire the actual systems, with sustainment expenditures coming from Operations and Maintenance. RDT&E and Procurement appropriations are often termed the “investment accounts,” and together they typically comprise roughly one-third of the annual defense budget in any given year.

RDT&E funds are further categorized to reflect different types of research efforts: 1) Basic Research, 2) Applied Research, 3) Advanced Technology Development, 4) Advanced Component Development and Prototypes, 5) System Development and Demonstration, 6) RDT&E Management Support, and 7) Operational System Development. In Table 2 below, it can be noted that the activity categories and purposes correlate somewhat to degree of end product (i.e., system) applicability or technological maturity (corresponding with a reduction in uncertainty and complexity), and that funding and management agents change depending upon the research category.

Table 2. Research, Development, Test and Evaluation Categories (DOD 7000.14-R)

Major Force Program 6 - RDT&E					
CAT#	ACTIVITY	BA*	PURPOSE	WHO	FUND MANAGED
01	Basic Research*/ RESEARCH #	BA-1	EXPAND KNOWLEDGE/ STUDIES / EXPERIMENTS	UNIV / LABS	RDT & E COMMANDS / SERVICES
02	Appl Research*/ EXPLOR DEVEL #	BA-2	DEVELOP & EVALUATE TECHNICAL FEASIBILITY	UNIV / LABS / CONTRACTOR	RDT & E COMMANDS / SERVICES
03	Adv Tech Devel*/ ADV DEVEL #	BA-3	PROOF OF CONCEPT/ BRASSBOARDS	LABS / FIELD / CONTRACTOR	RDT & E COMMANDS / SERVICES
04	Adv Tech Devel & Prototypes*/ DEM / VAL #	BA-4	SPECIFIC WEAPON SYSTEM	LABS / CONTRACTOR	PMO
05	Sys Dev & Demo*/ ENGR DEVEL #	BA-5	PROTOTYPE / EMD	CONTRACTORS / FIELD ACTIVITY	PMO
06	RDTE Mgmt Spt*/ MGMT & SPT #	BA-6	TEST RANGES / CIVILIAN RANGES	TEST RANGES	RDT & E COMMANDS / HEADQUARTERS
	Operational Systems Devel#	BA-7	IMPROVE PERFORMANCE OF PRODUCTION SYSTEM (R&M)	CONTRACTOR/ FIELD ACTIVITY	PMO (FUNDING IS NOT ALWAYS RDT&E, THE MFP IS <u>NOT</u> 6, R & D)
# Per FYDP Structure Mgt Hnbk (DoD 7045.7-H)		* Per FMR (DoD 7000.14-R)		<u>Legend</u> FYDP = Future Years Defense Plan FMR = Financial Management Regulation	

Depending upon the type or purpose of a research and development transaction, an appropriate “color of money” must be used to satisfy financial management regulations. Procurement funds are used for items the DoD wishes to have produced, or for items already developed and commercially available for purchase.

It is also apparent in both the 5000 series and FAR/DFARS documents that acquisition procedures and governance vary according to dollar size of transactions. The DODI 5000.2 prescribes Acquisition Categories (ACAT) per Table 3 below.



Table 3. Description and Decision Authority for ACAT I – III Programs
(DODI 5000.2, May 2003)

Acquisition Category	Reason for ACAT Designation	Decision Authority
ACAT I	<ul style="list-style-type: none"> MDAP (10 USC 2430, reference (n)) <ul style="list-style-type: none"> Dollar value: estimated by the USD(AT&L) to require an eventual total expenditure for research, development, test and evaluation (RDT&E) of more than \$365 million in fiscal year (FY) 2000 constant dollars or, for procurement, of more than \$2.190 billion in FY 2000 constant dollars MDA designation MDA designation as special interest 	ACAT ID: USD(AT&L) ACAT IC: Head of the DoD Component or, if delegated, the DoD Component Acquisition Executive (CAE)
ACAT IA	<ul style="list-style-type: none"> MAIS: Dollar value of AIS estimated by the DoD Component Head to require program costs (all appropriations) in any single year in excess of \$32 million in fiscal year (FY) 2000 constant dollars, total program costs in excess of \$126 million in FY 2000 constant dollars, or total life-cycle costs in excess of \$378 million in FY 2000 constant dollars MDA designation as special interest 	ACAT IAM: ASD(C3I)/DoD CIO ACAT IAC: CAE, as delegated by the DoD CIO
ACAT II	<ul style="list-style-type: none"> Does not meet criteria for ACAT I Major system <ul style="list-style-type: none"> Dollar value: estimated by the DoD Component Head to require an eventual total expenditure for RDT&E of more than \$140 million in FY 2000 constant dollars, or for procurement of more than \$660 million in FY 2000 constant dollars (10 USC 2302d, reference (o)) MDA designation⁴ (10 USC 2302(5), reference (p)) MDA designation as special interest 	DoD CAE or the individual designated by the CAE
ACAT III	<ul style="list-style-type: none"> Does not meet criteria for ACAT II or above Less-than a MAIS program 	Designated by the DoD CAE at the lowest level appropriate

Notes:

1. In some cases, an ACAT IA program, as defined above, also meets the definition of an MDAP. The USD(AT&L) and the ASD(C3I)/DoD CIO shall decide who will be the MDA for such programs. Regardless of who is the MDA, the statutory requirements that apply to MDAPs shall apply to such programs.
2. An AIS program is an acquisition program that acquires IT, except IT that involves equipment that is an integral part of a weapon or weapons system, or is an acquisition of services program.
3. The ASD(C3I)/DoD CIO shall designate programs as ACAT IAM or ACAT IAC. MAIS programs shall not be designated as ACAT II.
4. As delegated by the Secretary of Defense or Secretary of the Military Department.

ACAT designated programs are further arrayed by application or functional area (currently Battlespace Awareness, Command & Control, Focused Logistics, Force Application, Force Protection, Joint Training, Net Centric warfare). This is the “traditional” approach for the acquisition of items that are not yet mature enough for production nor commercially available.

Contract purchase thresholds, along with associated degrees of governance, are also stratified in the DFARS. For example, a “micro-purchase” is an acquisition of supplies or services, the aggregate amount of which does not exceed the micro-purchase threshold. That threshold varies somewhat according to the operational significance of the transaction: it generally means below \$2,500, but it can mean \$2,000 for construction projects subject to the Davis-Bacon Act; and \$25,000 for acquisitions of supplies or services contracted outside the United States in support of a contingency operation or catastrophic recovery.



To minimize transaction costs for these relatively simple and straightforward, low-dollar-value transactions, maximum use of the government purchase card (vice written purchase orders) is encouraged. Similarly, "Simplified Acquisition Threshold (SAT)" generally refers to transactions below \$100,000, except for acquisitions of supplies or services that are to be used to support a contingency operation or catastrophic recovery, for which the amount is up to \$250,000 for any contract to be awarded and performed, or purchase to be made, inside the United States; or \$1,000,000 for any contract to be awarded and performed, or purchase to be made, outside the United States.

Micro-purchase and simplified acquisition thresholds are important identifying characteristics of transactions used by the DoD that allow the use of simplified acquisition procedures in order to reduce transaction costs (the recognized administrative burden, and cost incurred in larger transactions). Levels of decision move along this scale as well. Purchases of up to \$5 million or even \$10 million, depending upon circumstances, such as urgency or whether the item procured is "commercial," can sometimes be made under such streamlined procedures (FAR Parts 2 and 13).²⁶

Competition as a governance mechanism (a powerful economic force for price reduction) is explicitly required for large purchases, both in statute and regulation. Although the possibility of ex-ante competition followed by ex-post lock-in and bi-lateral monopoly is somewhat overlooked.

Some allowances are made for contracting officer discretion and determination. For example, exceptions to the rule that permit contracting without providing for full and open competition are: 1) only one responsible source and no other supplies or service will satisfy agency requirements, 2) unusual and compelling urgency, 3) industrial mobilization; or engineering developmental, or research capability; or expert services, 4) international agreement, 5) authorized or required by statute, 6) national security, and 7) public interest (FAR 6.302). Each of these statutory authorities must be fully supported, documented, and approved by the designated contract agency approval authority in the form of a Justification and Approval (J&A). Note the danger that many of these exceptions can subject DoD to a subsequent "holdup" resulting in higher costs, lower performance or schedule delays.

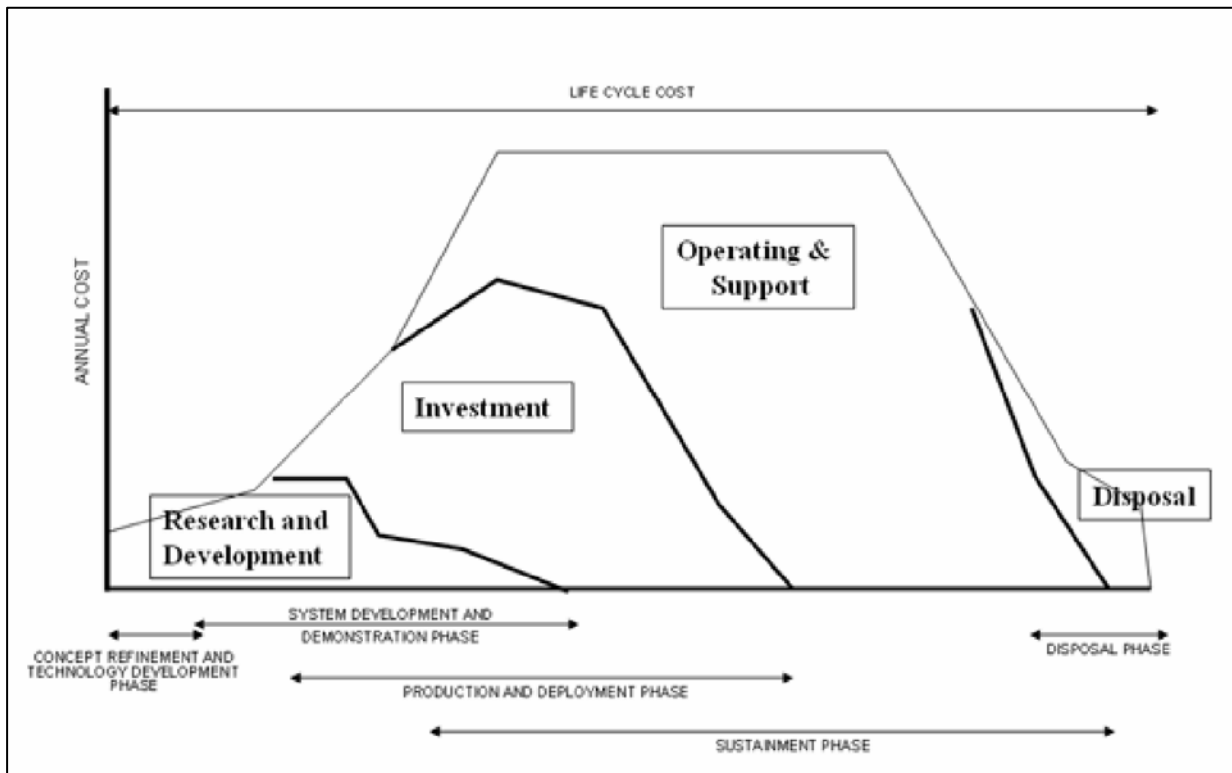
Finally, with regard to the acquisition transaction feature of cost, a long-standing paradigm exists in the DoD with regard to system lifecycle costs. As shown in Figure 2, phases of a notional program's lifecycle correspond to budgetary appropriations and cost categories. While the relative amounts shown in each category may not hold across every program or technical commodity, this model has been demonstrated often enough to be a widely accepted view of how costs are typically distributed.

²⁶ It is also within the FAR that socio-economic objectives are expressed as constraints upon transactions, such as those purchases between \$2,500 and \$100,000 being set aside for small and disadvantaged businesses.



Figure 2. Illustrative Program Lifecycle

(Defense Acquisition Guidebook, Nov. 2004, p. 43)



An interesting aspect of TCE can be introduced into the Lifecycle Production Cost graph illustrated in Figure 2. The first stage of the lifecycle is characterized by great uncertainty and complexity as the product is being developed. Our earlier discussion of TCE suggests transaction costs are likely to be high in this phase (especially as a fraction of the total dollar costs of this phase of the program) as these early transactions tend to be governed more by Cost Plus contracts. However, once the technology is well understood and the product clearly specified, uncertainty and complexity are reduced and transaction costs are likely to be a much smaller part of the Investment phase, where contracts are more likely to be governed by competition for fixed-price contracts. However, towards the end of that phase, asset specificity could lead to opportunistic renegotiation of the production contract if the company is in a position to “hold up” the government (say by significantly raising the cost of any change orders). Both production and transaction costs in the classic Lifecycle cost model illustrated in Figure 2 could end up being very helpful to Program Managers.

We have already revealed a broad range of defense acquisition transactions with varying degrees of governance and administration requirements according to dollar size. But we can also point out that operational significance, specifically the implication of time urgency or compelling need (temporal specificity), can be at least as important a feature.

A recent initiative to accommodate joint urgent operational needs is codified in CJCSI 3470.01 (July 15, 2005). It establishes policy and procedures to facilitate procurement of urgent, execution-year combatant commander needs outside of the DoD 5000 series process, specifically for programs of ACAT II level or below. Generally, these are considered to be life- or combat mission-threatening needs, which were previously unforeseen and that are now required to be fulfilled within months versus years.

While this new process is not intended to replace the JCIDS process of formal requirements development, it is meant to accelerate the fielding of readily available systems for wartime use. Each of the services has a similar initiative for rapid response or accelerated deployment capability using COTS or Nondevelopmental Items (NDI). One such example is the Army's Warfighter Rapid Acquisition Program (WRAP). It is a fund of approximately \$100 million per year that the Army uses to rapidly procure relatively low-cost but high-leverage systems that performed well in experimentation. The WRAP effort has reportedly reduced acquisition cycle-time for systems procured by an average of 12 months. The Marine Corps and the Air Force* have established similar rapid acquisition programs in FY 2001 and FY 2002, respectively (ADR, 2000).

In keeping with the aspect of timeliness as it relates to transaction procedures and governance, we have also noted above that commercial availability can serve as an important factor. Likewise, within the realm of system development, technology maturity (or "readiness") levels dictate the appropriate RDT&E funding categories to be employed, and determine whether progression into advanced development or production is warranted.

Technology Readiness Levels (see Table 4 below) are measures used to assess the maturity of evolving technologies prior their incorporation into a system. This characteristic can be viewed as addressing both timeliness and customer quality-of-use or degree of technical performance. Usually, when new technologies emerge, they are not suitable for immediate application. Both hardware and software typically go through a process of experimentation, refinement, and increasingly rigorous testing until they are considered mature enough to be applied by end-users in military applications. The scale below is now used by the DoD to assess maturity before the Department commits to further investments in technology. This paradigm correlates well to a scale of increasing certainty or declining uncertainty. For example, depending on a trade-off between urgency of the requirement and cost, it may be desirable for technology to be at a 6 or 7 rating on the scale before commencing an advanced development (system-level development and demonstration) program.

* Air Force Instruction 10-602 defines their Quick Reaction Capability (QRC) procedures for "any system or equipment that will or must be deployed (dictated by mission requirements) in a period of time that does not allow for routine planning, budgeting, and procurement. Deployment may occur with less than a complete support package. However, special provisions shall be made to effect lifecycle support."



Table 4. Technology Readiness Levels in the Department of Defense (DoD)

(Source: DOD (2004), *DODI 5000.2 Acquisition System Guidebook*)

Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins with to be translated into applied research and development. Example might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include 'high fidelity' laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in a operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and 'flight qualified' through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system 'flight proven' through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.

Technical complexity within a system can be thought of as moving along a graduated scale, from low to high.²⁷ The integration of multiple technologies in various states of component maturity (uncertainty) could hinder the attainment of system availability or performance reliability until fully state-of-the-art (Simon, 1996). Another transaction approach to satisfying user needs in a timely fashion is through Advanced Concept Technology Demonstrations (ACTDs), introduced in 1994 to enable rapid, cost-effective introduction of new capabilities.

ACTDs seek to rapidly field near-term materiel solutions, generally within two to four years. ACTDs have three principal objectives: understanding the “in-the-field” military utility of a new technology’s application before committing to procurement, developing operational concepts to employ the best use of a new capability, and providing residual capabilities directly to the combatant forces as equipment by-products of the demonstration (positive spillovers or externalities). ACTDs are prioritized to respond to critical military needs as determined by the Joint Requirements Oversight Council (JROC) with near-term solutions based on mature or nearly mature technologies. If successful, ACTDs may transition into the more formal DoD 5000 acquisition process at the appropriate juncture as “non-traditional acquisition” (ADR, 2000).

Several other non-traditional acquisition approaches to enhance timeliness, satisfy user needs, or reduce administrative burdens are worthy of mention here:

Limited Production-Urgent is an Army-type classification allowing for limited numbers of items to be procured on an urgent basis without full classification as a standard type item. This could foreseeably provide capability prior to completion of all required testing, man-rating, etc. for a normal materiel release by organizations representing end-users. (AR 71-32, March 3, 1997, HQDA)

In 1994, Congress authorized the use of Other Transactions (OT) for the development of weapon prototypes such as projects often undertaken by the Defense Advanced Research Projects Agency (Technology Investment Agreements or TIAs). Under 10 USC § 2371, the term refers to any transaction vehicle other than a procurement contract, grant or cooperative agreement. Under such authority, the transactions need not comply with procurement laws and regulations such as the FAR/DFARS. A principal objective of the legislation was to encourage a larger number of commercial firms to participate in developing defense systems, thus expanding the technology base and tapping into commercial technologies.

Born from the Goldwater-Nichols legislation of 1986, the commander of the US Special Operations Command has unique acquisition authorities vested by Title 10 United States Code, Section 167. It provides for the development and acquisition of special operations forces peculiar equipment, the authority to exercise the functions of the head of agency (HOA), and the authority to execute funds (through the establishment of Major Force Program 11). This separate authority and funding account places all aspects of requirements, acquisition, and resources in one organization for SOF-peculiar materiel. In

²⁷ And though these authors have found no similar rubric or strata, the classical systems theory description of “many parts and many interactions” is a useful construct, along with other system properties such as non-linear relationships among components, etc.



FY05, the total MFP-11 budget was \$6.6 billion, one-third of which was for acquisition-related transactions.

Thus far, we have briefly described a range of transactions within the wide realm of materiel acquisition—from small, inexpensive items that are commercially available to large, complex developmental systems that are still beyond the reach of technical maturity and purchase availability (where much contracting uncertainty lies). We have also noted common and relative aspects of timeline availability, dollar size, and technical performance, and how such attributes impact the governance of those transactions.

D) Government Contract Types and Risk

The contracting officer's primary concern is the overall price the Government will actually pay. The contracting officer's objective is to negotiate a contract of a type and with a price providing the contractor the greatest incentive for efficient and economical performance. The negotiation of a contract type and a price are related and should be considered together with the issues of risk and uncertainty to the contractor and the Government. Therefore, the contracting officer should not become preoccupied with any single element and should balance the contract type, cost, and profit or fee negotiated to achieve a total result—a price that is fair and reasonable to both the Government and the contractor. (FAR, Part 15.405(b))

Among the key events in any government acquisition transaction is the contract award. The DoD employs contracts as vehicles for the accomplishment of acquisition objectives. The FAR (and DoD Risk Management literature) state that the three attributes we have been discussing here: cost, timeliness and technical performance/quality, are also the primary areas of risk in any transaction (FAR, Part 7.105(a)(7)). The policy dictates that determination of contract type “should be closely related to the risks involved in timely, cost-effective, and efficient performance” (FAR Part 15.404-4(d)). “Type” of contracts refers to the contract compensation arrangement for defense contractors. And contract type selection is the principal method of allocating cost risk between the Government and the contractor.

As discussed earlier, a variety of contract types are available to the DoD and its contractors to provide flexibility in acquiring the large variety and volume of supplies and services needed. Selecting the best contract type and price is a matter for negotiation and requires the exercise of sound judgment by both parties, judgment that this study proposes can be sharpened through the application of Transaction Cost Economics. Both parties seek to negotiate the most appropriate contract type for the kind of work to be performed in order to minimize spending and performance from the government's perspective and to maximize profits from the contractor's perspective.

As seen in the FAR statement above, the government's objective is to negotiate a contract type and price (or estimated cost and fee) that will result in reasonable contractor (profit) risk and provide the contractor with the greatest incentive for efficient and economical performance. Contracting officers are directed to consider the complexity as well as commercial availability and urgency of their transactions (FAR Part 5.203(b)). The larger the scale or more technical complexity of the transaction, the greater the perceived contract risk.



As briefly introduced above in Section 2.1, contracts are typically grouped into two broad categories: cost-reimbursement contracts and fixed-price contracts (FAR, p. 16.1-1). In cost-reimbursement type contracts, the government assumes more of the risk. These contracts are suitable for use in research and development efforts “when uncertainties involved in contract performance do not permit costs to be estimated with sufficient accuracy to use any type of fixed-price contracts” (FAR, p. 16.3-1). Such contracts epitomize the conditions of incomplete contracting described earlier, where there is significant uncertainty (and/or complexity) that impacts both sides of the transaction.

Cost-reimbursement type contracts include: cost-contracts, cost-sharing contracts, cost-plus-incentive-fee contracts, cost-plus-award fee contracts, and cost-plus-fixed-fee contracts, and place the burden of risk upon the government. The government is willing to accept the risk of a cost-reimbursement type contract in order to motivate contractors to participate in the transaction, encourage them to propose solutions, and to provide products for which there is often a limited market. In these cases, the government will attempt to tie the contractor’s profit to his performance, often based upon cost, schedule or technical performance parameters.

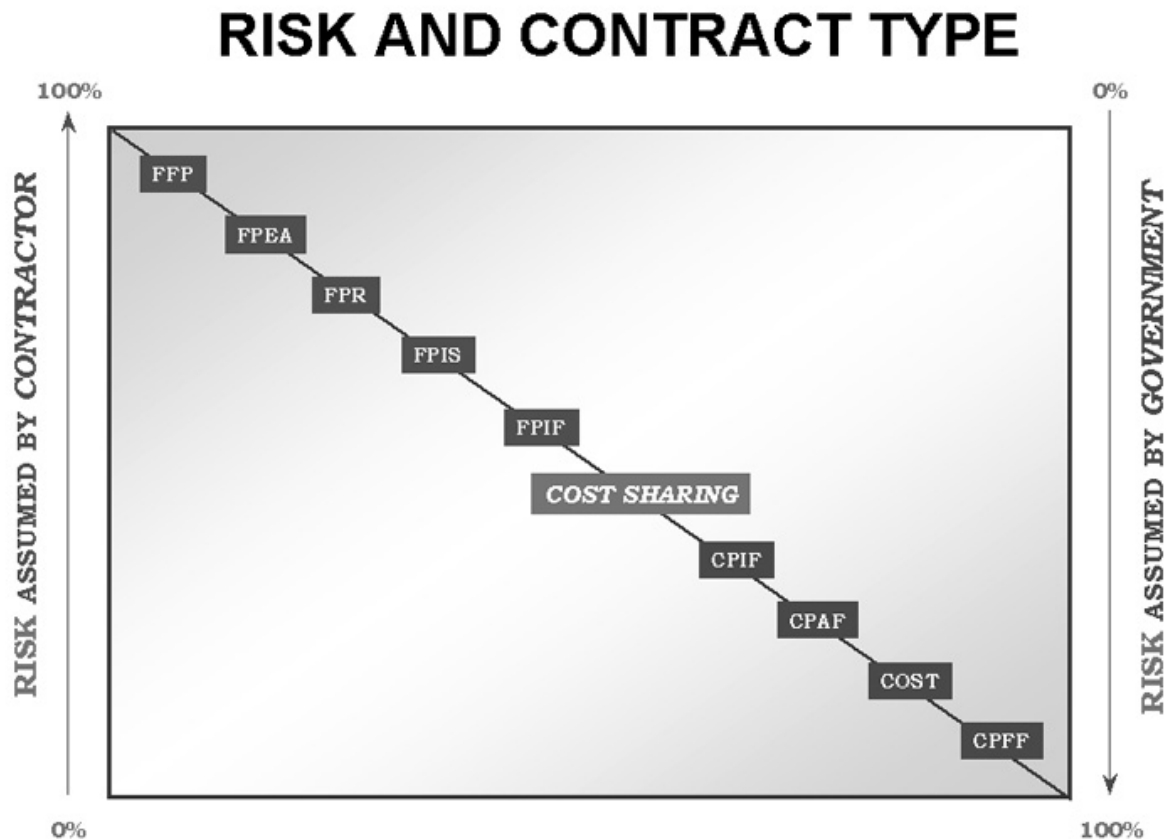
Conversely, fixed-price contracts are usually used for production (for commercially available products, or after completion of system development) or paper studies (prior to advanced development) when the overall risk is “minimal or can be predicted with an acceptable degree of certainty” (FAR, p. 16.1-1). Complete contracting conditions exist in instances where there is limited uncertainty and complexity.

Fixed-price contract types include: firm-fixed-price contracts, fixed-price contracts with economic price adjustment, fixed-price incentive contracts, fixed-price contracts with prospective price redetermination, fixed-ceiling-price contracts with retroactive price redetermination, and firm-fixed-price level of effort contracts. All of these enable the government to negotiate a payment for the desired effort with the additional capability, in some instances, to adjust for changes in the economy, or level of work produced. The risk is placed on the contractor because the government’s price is fixed regardless of the costs incurred by the contractor. However, the further assumption is that these “best utilize the basic profit motive of business” by allowing the contractor to profit based on whatever savings he can generate. Again, while ex-ante competitive bidding for a fixed-price type contract may reveal the best price to the government, the possibility of asset specificity leading ex-post to a holdup (for instance, a renegotiation of the price) does not appear to be explicitly addressed.

A graphic representation of risk and contract types is shown below in Figure 3. (See Appendix B for a Comparison of Major Contract Types for stratification of contract types, when they are used, risk, etc.)



Figure 3. Continuum of Contract Risk and Type



There are two primary methods of awarding contracts, as mentioned earlier in Section 2. The sealed bidding method is the simplest and is used for smaller, less complex transactions—normally fixed-price (via IFB). The contract is awarded after a review and evaluation of bids determined as “the responsible bidder whose bid, conforming to the invitation for bids, will be most advantageous to the Government, considering only price and the price-related factors included in the invitation” (FAR, p. 14.1-1). This is essentially an attempt to minimize transaction costs in the case where there is little uncertainty or complexity or asset specificity involved in the transaction (as proxied by relatively low dollar values).

The other method of awarding contracts is by negotiation (via RFP). This process is significantly more complex—to award and administer—requiring proposals, information and sometimes demonstration of technologies before the final contract is awarded. Table 5 below shows typical contract types by current acquisition phases.

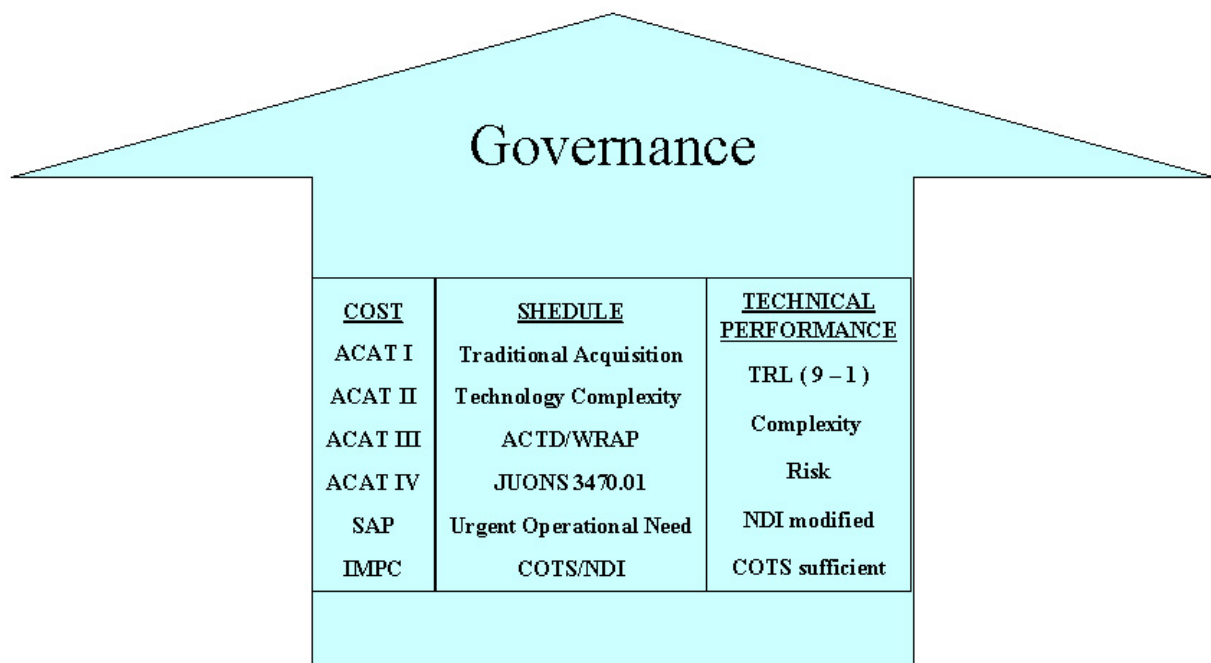
Table 5. Typical Contract Type by Phase (DAU, 2004)

CR	TD	SDD/SI	SDD/SD	PROD
CPFF, FFP	CPFF, FFP	CPFF, CPIF	CPIF, CPAF	FPI(F), FFP

E) Transaction Attributes Affect Acquisition Governance

The limited scope of this research study can hardly do justice to the vast arena of contract management by our mere mention of contract types according to risk, etc. Our purpose is to simply emphasize that defense acquisition transactions are multi-faceted with multiple variants, but primarily focus on aspects of cost, schedule and technical performance as success measures, governance determinants, and influences on the contracting vehicle. Other factors that have an important bearing on acquisition transactions include economic factors such as whether or not the supplier base is highly competitive; whether or not requirements are fully known (the degree of uncertainty); the materiel mission environment, etc. However, our observations of the many types of transactions for acquiring materiel and the range of contract vehicles employed exhibit a somewhat linear incorporation of governance along the growth lines of cost, schedule and technical performance risks, as in Figure 4 below. Perhaps the most important conclusion to draw from this discussion is that the TCE characteristic of asset specificity does not appear to have been captured as a key concern of acquisition transactions in the traditional applied literature or in defense and other federal acquisition policy documents; although, we have found practices that (at least indirectly) address this important characteristic of economic behavior.

Figure 4. Governance According to Transaction Attributes of Cost Schedule and Technical Performance



F) The Cost of Acquisition Transactions

While much attention in defense acquisition is placed upon what is spent on contracts or in budgetary categories as production costs, less emphasis seems to fall upon the costs of the transactions themselves. However, Congress has focused upon the size of the acquisition workforce, presumably as a driver of administrative costs associated with acquisition. Congress passed legislation throughout the 1990's aimed at significant reductions in the acquisition workforce over a span of 5-10 years (CSRS Acq Reform Issues, 2002).

For example, the Defense Contract Management Agency (prior to the March 2000 Defense Contract Management Command) had reduced its size from approximately 24,000 contract administration services personnel in 1990 to approximately 11,000 personnel in 2001. In 2000, it was estimated that of \$91 billion dollars of unliquidated obligations on defense contracts were being administered under the purview of the Defense Contract Management Agency. Upwards of 25% of the transactions were for "small dollar contracts"—purchase orders valued under \$2,500—with an approximate administration cost of \$300 each. As Eiband suggests, "procurement complexity, lead time, and administrative costs all increase as one ascends the hierarchy" (Eiband, ARJ). Similar oversight or administrative services are also performed by agencies such as the Defense Contract Audit Agency and the Defense Finance and Accounting Service, who audit and pay contractors respectively.

G) Acquisition Practices

Described below are other areas where the DoD has attempted to address transactions costs, though perhaps not using TCE terminology. The business of defense materiel acquisition has gone through a number of reform cycles, with particular emphasis on adoption of best practices and approaches to constrain cost, improve cycle-time, improve discipline. Such initiatives include using electronic commerce to reduce paperwork and its associated costs, use of commercial standards and processes, off-the-shelf components, and best business practices. Others include using performance (versus technical) specifications and contracting techniques for sharing of cost savings with contractors, such as Value Engineering Change Proposals. Rand cited a total of sixty-three such initiatives in their recent report on the status of reforms undertaken in the 1990s. Some of the most widely accepted are described below, each involving a strategic shift in the relationship between government buyers and private industry sellers. Interestingly, each example is associated with some aspect of economic behavior emphasized in the TCE literature.

1. Multi-year Contracting and Frequency

Motivating and incentivizing industry partners in DoD acquisition typically focuses on ensuring competition through the use of multiple sources, component breakout, leader/follower development and production, dual source of critical components, etc. The DoD assumes that a competitive business environment exists, and indeed is compelled under the Competition in Contracting Act of 1984, as amended, to acquire supplies and services through the use of full and open competition. However, as indicated above, sole source procurements can be justified; and in that environment, cost savings might still be attained through the use of a variety of business initiatives such as value engineering,



multiyear procurements and other types of shared cost savings between government and the contractor.

Multi-year contracting is seen by many to provide a more stable and longer-term relationship between the government buyer and industry supplier, versus the more typical annual commitments from congressional appropriations and authorizations. The TCE characteristic of frequency emerges in multi-year contracting, whereby the government commits to purchase of goods or services beyond a single year (retaining its unilateral right to terminate for convenience). If it is credible, this limited commitment on the part of government can afford contractors the perceived stability needed to motivate investments in capital improvements. The Federal Acquisition Streamlining Act of 1994 encourages longer-term supplier relationships. But multi-year contracts must still demonstrate significant advantage in pricing over annual contracts and may not extend for more than a five-year period. Full funding need not necessarily be in place for the total duration of the buy, but termination/cancellation charges apply if the contract has to be cancelled or is not funded in accord with the programmed buy (Rand, 2005).

2. Integrated Product and Process Development and Asset Ownership

Integrated Product and Process Development (IPPD) was instituted to save costs by ensuring a "systems" approach to acquisition. IPPD helps prevent additions and/or changes late in the lifecycle for factors "forgotten" earlier, such as supportability, testability, and producibility. The idea was not new, and grew out of systems management thinking which became prevalent in the 1970s. A primary tenet of IPPD is to recognize the multi-disciplined nature of complex projects, like weapon system development, incorporate a cross-functional methodology to planning and analysis of requirements at the front end of systems development. Absolute necessity for both early problem discovery and buy-in of all participants at all levels—if and only if—well led. Integrated Product Teams (IPTs) are the means through which IPPD is implemented. IPTs are cross-functional teams that are formed for the specific purpose of delivering a product for the customer. IPT members should have complementary skills and be committed to a common purpose. DoD zealously implemented the IPPD philosophy with four formal levels of hierarchical IPTs—from project-level working groups to over-arching OSD-level "teams." Key in the IPT concept is the idea that a multiple perspective view of a problem early on may go a great ways toward advanced problem discovery and total realization of requirements across areas like designing, testing, supporting and maintaining, improving, manufacturing, packaging, etc. Changes in the design of a system early on prevent much costlier changes later.²⁸

²⁸ IPT/IPPD is now a core tenet embodying the belief that a breadth and diversity of perspectives is a problem-solving strength, and operationalizing systems-theory principles such as Ashby's Law of Requisite Variety, replacing traditionally adversarial relationships among key players (users, acquirers, testers, funds managers, contractors, and other stakeholders) with cooperation and teamwork improves product quality and supportability.



3. Cost as an Independent Variable (CAIV)—Heightened Awareness/Shared Risk

Another one of several recent initiatives aimed at controlling costs in the DoD is cost as an independent variable (CAIV), where a system's ultimate objectives of performance are re-examined as costs increase greatly relative to performance gains. The CAIV philosophy means that cost will be treated as a constraint or fixed variable, much like a fixed budget, among the three variables (cost, schedule and performance). In past endeavors, performance was seen as the paramount objective and was the more programmatically stable variable. Cost and schedule increased as needed to deliver the desired capability. Under the CAIV philosophy, stronger consideration is to be given for fixing the costs of system development programs. Program managers are now required to establish realistic objectives for their programs early on and trade off performance and schedule continually to achieve a balanced set of goals that achieve cost objectives. The policy accompanies evolutionary acquisition as a means of delaying full performance delivery, if necessary.

Implementation of the philosophy could be extended to contracting strategy, whereby the contractor might be required to address cost targets derived from CAIV estimates in his proposal and later be rewarded with specific incentives for their attainment. Incentives for government program managers to use CAIV to trade off excessive performance requirements of a system are that funds might perhaps be better applied toward the most achievable parameters, and ultimate cancellation of the program may be avoided. Contractors involved would foreseeably share these aims as well as continued profit motivation from viable business programs (Rand, 2005).

4. Alpha Contracting for ex-ante Discovery

Alpha contracting is all about ex-ante discovery about the contract terms within incomplete contracting, to encourage mutual compliance ex-post. The government and industry partnership is central in the military acquisition domain—with both parties pursuing both common and separate goals based upon their buyer and seller roles. The government's traditional contracting approach (before acquisition reforms of the last decade) required successive iterations between the client and the supplier—to discover the client's requirements and the applicable supplier technologies—until a relatively complete contract could be written. In Alpha Contracting, this traditional sequential interdependency relationship has changed to a closer reciprocal interdependency relationship, a more symmetrical one, in which the client and supplier work together to define the requirements and discover solutions. Again, the Federal Acquisition Regulation gives guidelines for this dialogue:

The Government must not hesitate to communicate with the commercial sector as early as possible in the acquisition cycle to help the Government determine the capabilities available in the commercial marketplace. The Government will maximize its use of commercial products and services in meeting Government requirements. (FAR, Part 1.102-2)

Alpha Contracting has evolved from a 1990s-era reform initiative aimed at improving government and contractor communications in order to increase efficiency and effectiveness. At its very foundation is a need for increased trust and teaming toward common government/industry objectives, within the paradigm of their buyer/seller relationship. By encouraging more collaboration early in the contracting negotiations phase,



Alpha Contracting reduces procurement costs and cycle-time via joint and concurrent processes and information flows. Key activities in the process are: specification of requirements, preparation of the statement of work, negotiations and executive review. Cumulatively, these activities reduce uncertainty and complexity, allowing for writing a more complete contract and, thereby, reducing transaction costs.

Even though direct savings may be hard to quantify, most agree the savings derived from Alpha Contracting are substantial, even if the only savings counted is the increase in the program office staff's time free to solve other problems (Nissen, 1997). As Siemsen (2002) explained, the indirect benefits extend to both government and contractor as monitoring costs of other agencies like Defense Contract Audit Agency (DCAA) and Defense Contract Management Agency (DCMA) are precluded. This initiative actually seeks and obtains the information that enables a trust-based partnership. The shift from sequential to concurrent requirements definition and design is happening in many industries, not only DoD acquisition. For example, the construction industry has adopted the design/build approach.

In addition to collaborating on the requirements definition and contracting phase of new product development, the interpersonal closeness developed in the Alpha Contracting approach can be carried over to the development stage. The use of Integrated Product Teams (IPT) encourages the government's user representatives and the contracting supplier's engineers to work together as the new product is designed and the initial prototypes are built. In some instances, the government's representatives and the contractor's engineers are co-located in the same building. The potential advantages of this increasingly close interdependency between client and supplier are to shorten the design process, reduce development costs and, hopefully, to increase the quality of the resulting product. These advantages mainly apply to the government, but the advantage to the contractor in such closer interaction might be a perceived as generating a reputation that increases its likelihood of winning a future competitive bid. The potential disadvantages of this trend towards more concurrent engineering include the difficulties of achieving higher interdependencies between everyone involved in the project, including the government representatives and the contractor's engineers, designers and developers (Dillard & Zolin, 2005).

5. Evolutionary Acquisition Addresses Uncertainty Incrementally

A series of influential GAO reports on defense acquisition from 1996 through 2002 concluded that the DoD had repeatedly spent more time and money than originally planned on weapon systems, and urged that the Department:

Carefully assess technology (GAO 02-39 2001) and separate its research and development from its more advanced product development (i.e., mature the candidate technologies before commitment to advanced development) (GAO NSIAD-99-162, 1999).

Move to a "knowledge-based" approach, to learn more about a design's capability to satisfy requirements and a prototype's ability to be manufactured, earlier in the process (GAO 02-701, 2002).

Change the incentive environment to allow PMs to identify unknowns as high risks without suffering criticism and loss of support (GAO NSIAD-98-56, 1998).



An approach to mitigate these technological challenges, which are all related to uncertainty and complexity, is evolutionary acquisition, referred to by some outside of DoD as progressive acquisition. Also advocated by the General Accountability Office, it has evolved worldwide as a concept over the past two decades.

Evolutionary acquisition is an incremental development approach, using iterative development cycles versus a single grand design. DoD's adaptation of this approach is a major policy thrust in the series, and is the stated "preferred approach" toward all new system developments. This particular policy thrust is important as it offers an incremental approach to reducing uncertainty and complexity. It actually separates projects into smaller, less complex increments, thus having an impact on the amount of monitoring and controlling to be performed during system development.²⁹

6. Single Process Initiative Uses Frequency and Specialization

The Single Process Initiative was another coordinated idea among DoD and industry partners to allow contractors to use a single process for manufacturing both commercial and military products within their facilities, and to have common management and reporting on all defense contracts, versus multiplicity of same across separate contracts. Similar efforts through the 1990s were aimed at reducing DoD peculiar requirements seen as "bureaucratic." They are: use of performance ("what to") versus military ("how to") specifications, and even such application to service contracts, elimination of non-value-added packaging and reporting requirements, and elimination of detailed cost and pricing data for procurements under \$550,000 thresholds (Rand, 2005).

7. Reputation and the Use of Past Performance Data and Award for Best Value

Reputation has been shown to be an important enforcement mechanism to reduce ex-post opportunistic behavior, and is operationalized under this initiative. It incorporates individual contractor "Past Performance Data" for competitive contract award decisions and makes such information a key factor in the source-selection process. The concept is to further motivate positive cost schedule and performance outcomes across multiple DoD contracts by heightening performance visibility and requiring its evaluation and consideration. In a similar vein, the initiative of "Best-value Contracting" has also emerged, meaning that contracts can and should be awarded on the basis of "best value" (i.e., of cost, schedule and technical performance) rather than simply accepting the lowest bid. This was designed to simplify performance evaluation criteria, and to allow more flexibility for innovations to meet program objectives (Rand, 2005).

²⁹ These activities, while important in addressing uncertainty, are substantially increased under evolutionary acquisition (Dillard, 2003).



SECTION 4: SYNTHESIS AND CONCLUSIONS

A) TCE AND PUBLIC SECTOR OUTSOURCING

Transactions costs are not the only consideration for make-or-buy decisions. If that were so, then one might conclude the government should generally insource production of complex weapon systems and outsource janitorial services. For good reasons, the opposite is the more typical practice.³⁰ In evaluating transactions for their “make-or-buy?” decisions, firms typically consider both production costs and the cost of managing transactions (transaction costs).

The goal of this paper was to integrate and apply key principles of TCE (that previously focused on the firm) to government outsourcing. TCE recognizes organizations enter into bilateral contracts with suppliers, workers, managers, customers, firms, and other organizations that require costly governance (coordination and incentive) mechanisms.

It is time for government to do the same. The process for outsourcing determinations should have both credibility and precision. “Credibility” means, among other things, that the right competitions are held with rules assuring both products and services are adequately provided regardless of the winning proposal. “Precision” means established guidelines usually ensure the services in question are indeed provided at least cost to the public.

The implications of this discussion involve precision. In the case of outsourcing a transaction where complexity, uncertainty and asset specificity can lead to renegotiation, the choice of governance structure drives productive effort and unproductive bargaining. Ideally, contracts can be written that specify measures of performance, conflict resolution procedures, and conditions under which the contract can be modified, as well as provisions for sharing gains from transaction-specific investments. In reality, the tradeoff as it applies to outsourcing might be stated as follows. On the one hand, efforts to suppress opportunism contractually are limited by the costs of writing and enforcing contractual agreements, and rise with the complexity, uncertainty, and asset specificity associated with the transaction. This works against outsourcing. On the other hand, while integration within the organization mitigates these problems, internal principal-agent issues arise that sacrifice the high-powered incentives of the market and consequently require greater monitoring and administrative costs. This works in favor of outsourcing.

In summary, like private firms, government “make-or-buy?” decisions should look beyond production cost savings and forecast likely transaction costs associated with outsourcing. Moreover, government rules that prescribe particular contract types should be based on the four principal characteristics of transactions, and should offer contracts and mechanisms that encourage productive effort, protect transaction-specific investments, and discourage unproductive bargaining, influence and rent-seeking activities. The conventional wisdom in the transaction costs literature is that the decision to outsource should not be taken lightly. While the potential production-cost savings may well be tempting, there are associated costs and risks, albeit less obvious. They are less important (and might be negligible) for simple, one-time transactions where alternate suppliers are readily available. Yet, they can be critically important when the outsourcing arrangement is such that there is

³⁰ However, advocates of the arsenal system could argue (and have) that the hazards illuminated by TCE indicate production of complex weapon systems should be done internally.

only one supplier readily available in a complex and lengthy relationship. Hence, the decision to outsource must weigh production cost savings against the costs and risks associated with a critical source of supply being outside the firm's control. Those are generally referred to as the transaction costs of the outsourcing relationship. Thus, outsourcing is preferred only if the total costs are less than the costs of production with the firm's (in-house, organic) assets. That is, a firm should outsource only if the following is true:

Cost of in-house production + Agency Costs > Outsourcing + Transaction Costs.

B. IMPLICATIONS OF THIS SYNTHESIS

Comparing the two bodies of knowledge (TCE theory with DoD acquisition practice) leads to some interesting insights. There are two basic questions to consider. First, what does TCE tell us about improving DoD acquisition practices? And second, what does the body of practice in DoD acquisition management indicate for new research in TCE? Since our audience for this effort is DoD acquisition managers, we focus primarily on that first question—and consider how TCE can help DoD acquisition practice. Our tentative answer is in four related parts.

First, even though originally intended to study the make-or-buy decision, TCE offers useful insights for Program Managers strictly involved with the “buy” option. TCE highlights problems that can, and do, arise in outsourcing relationships, and provides useful indicators regarding their severity (i.e., the expected “transactions costs”). While the main body of TCE casts light on make-or-buy (vertical integration) issues, it also provides powerful insights into the effective management of outsourcing relationships.

Second, acquisition managers are not engaged in a game against nature. Current acquisition practices emphasize (properly) the management of risk. However, managing the relationship with industrial partners (contractors) is also very important. Program Managers need to anticipate issues that pertain to governing outsourcing relationships with the same vigilance with which they anticipate risks—with a view to managing and mitigating both sets of problems.

There is an inherent conflict between DoD and its contractors. The two have different objectives. DoD wants “better, faster, cheaper.” Contractors need to be profitable to survive. The key is for Program Managers to understand and anticipate the parties' divergent interests and to be prepared to deal with difficulties that might arise. Such situations are usually better addressed through anticipatory measures—such as well-crafted contracts which include appropriate incentives to align the interests of the two parties and encourage constructive behavior and provisions for governance of the relationship (especially ways to settle disputes).

Third, there is no universal solution to managing these relationships. Every outsourcing transaction involves a number of characteristics that can materially influence the nature of the relationship. TCE helps anticipate opportunistic behavior that can jeopardize the DoD-contractor partnership. While asset specificity is certainly a major cause of conflict for outsourcing relationships, there are a number of other possible causes. At minimum, Program Managers should assess contractual relationships using something like the stoplight method introduced in Appendix B to help anticipate, and prepare for, these difficulties.



Finally, DoD contracting practice would be greatly enriched by viewing defense transactions through the lens of TCE. An important insight is the opportunity to craft contracts based on the potential for opportunistic behavior, in addition to varying incentives based on shifting risk. Where there is significant scope for opportunistic behavior, contracts should pay special attention to the use of additional mechanisms to govern the outsourcing relationship. This suggests that existing guidance on contract types should be extensively revisited—an important first step in translating the theoretical insights of TCE into DoD practice.

APPENDIX A. A TCE BARGAINING GAME MODEL

A game is developed between two parties in a transaction ($i=1,2$) whose combined productive efforts endogenously generate the surplus:

$$(1) S = Ae_1^{\alpha_1} e_2^{\alpha_2}; \text{ where the standard Cobb-Douglas assumptions are satisfied.}$$

In the case of government outsourcing, the two parties could be an internal government customer and external private contractor.³¹ Each player can also engage in unproductive bargaining, b_i . This influence and rent-seeking activity consists of measures and counter-measures designed to preserve, capture or extract a larger share of the surplus. While effort expands S for both parties in the transaction, bargaining determines the share each player realizes. The combined costs of engaging in productive and unproductive activities (to generate and capture the surplus respectively) are assumed to dilute the share of surplus enjoyed by each player.

Player 1 chooses productive effort, e_1 , and unproductive bargaining, b_1 , to maximize his utility function:

$$(2a) U_1 = [1/2 + (b_1^\sigma - b_2^\sigma) - (1/2)(\gamma_1 b_1^2 + \beta_1 e_1^2)]S;$$

Similarly, player 2 chooses e_2 and b_2 to maximize her utility function:

$$(2b) U_2 = [1/2 + (b_2^\sigma - b_1^\sigma) - (1/2)(\gamma_2 b_2^2 + \beta_2 e_2^2)]S.$$

The first two terms in brackets in (2a,b) represent the net benefit to each player derived from bargaining over his share of the surplus, S . The last term represents the quadratic costs to each player of engaging in unproductive bargaining activities and productive efforts (respectively), as a share of S .

³¹ For instance, consider a government customer (or principal) that actively revises rules and regulations to allow more economical or flexible procurement on the part of a private contractor (or agent). This productive effort could lower the agent's input costs, thereby contributing to joint savings or a surplus. Meanwhile, suppose the agent simultaneously engages in productive investments in human capital or new processes that further contribute to the surplus. "By exerting effort the [agent] can hold down its realized costs. For example, it can, at some cost to itself, search for lower-priced raw materials...or it can manage its...inventories so that it is not left holding excessive stocks" (McAfee & McMillan, 1988, p.17). The challenge remains how any gains, savings or surpluses are shared between the principal and the agent.

From (1), the parameter associated with the marginal benefit of effort (for each player $i=1,2$) is α_i . From (2a,b), the parameter associated with the marginal cost of effort is β_i . Meanwhile, the parameter associated with the marginal cost of bargaining is γ_i . Under the simplifying assumption the marginal benefit of bargaining is the same for both players, or σ , the first order conditions (four equations derived from maximizing 2a with respect to e_1 and b_1 , and 2b with respect to e_2 and b_2) can be solved independently for the optimal bargaining activity of each player:

$$(3a) \quad b_1^* = (\sigma / \gamma_1)^{1/(2-\sigma)},$$

and

$$(3b) \quad b_2^* = (\sigma / \gamma_2)^{1/(2-\sigma)}.$$

Substituting (3a,b) into the first order conditions yields the optimal effort contributed by each player:

$$(4a) \quad e_1^* = \{2\alpha_1 / (\beta_1(2 + \alpha_1)[1/2 + (b_1^* - b_2^*) - (\gamma_1/2)(b_1^*)^2])\}^{1/2},$$

and

$$(4b) \quad e_2^* = \{2\alpha_2 / (\beta_2(2 + \alpha_2)[1/2 + (b_2^* - b_1^*) - (\gamma_2/2)(b_2^*)^2])\}^{1/2}.$$

This combined effort generates the surplus (substituting (4a,b) into (1)):

$$(1') \quad S^* = A(e_1^*)^{\sigma_1} (e_2^*)^{\sigma_2}.$$

Finally, substituting (3a,b), (4a,b) and (1') into (2a,b) yields the utility each player achieves as a result of the joint decisions of the two parties to the transaction: (2a') U_1^* , and (2b') U_2^* .

A reasonable simplifying assumption is that the marginal cost of bargaining is the same for both parties in the transaction, or that $\gamma_1 = \gamma_2 = \gamma$. From (3a,b), this implies symmetric bargaining (or influence) activity by each player at the optimum, or $b_1^* = b_2^* = b^*$. The comparative static results from the model appear in Table A1 below.³²

³² Relaxing the simplifying assumptions that the marginal benefit and costs of bargaining are the same for both players, the simulations reveal much the same results as those reported here for the complete analytical solution.

TABLE A1. Comparative Static Results

		e1	e2	b	S
Productive Effort Parameters	α_1	+	0	0	+
	α_2	0	+	0	+
	β_1	-	0	0	-
	β_2	0	-	0	-
Unproductive Bargaining Parameters	σ	-	-	+	-
	γ	+	+	-	+

In general, the less complex and uncertain a transaction, the lower the degree of asset specificity, and the greater the frequency, then the lower β and σ , and the higher γ . From Table 3, at the optimum, reducing β increases productive effort, ei, and the surplus, or gains from exchange, S. Also from Table 3, reducing σ and increasing γ lowers unproductive bargaining, b, and boosts productive efforts, ei, and, consequently, the surplus, S. The higher the combined effort (e) and joint surplus (S), the greater the potential returns from outsourcing.³³

APPENDIX B. AN OUTSOURCING RISK ASSESSMENT METHOD

A thesis by Powell proposes a method for defense managers to assess the risks associated with a proposed outsourcing action.³⁴ Basically, aspects of the new relationship are related with a stoplight scheme. For example, if there is a high degree of asset specificity involved, there would be a red light in that category, and a higher degree of risk is indicated. Powell intended the light scheme to increase visibility of areas where management attention is important, and where managers ought to focus their risk-reduction efforts.

That application is certainly valid, but there's another wrinkle. The study of Transaction Cost Economics indicates that risk-reduction measures (even if highly effective) are not risk-elimination panaceas. Accordingly, one can expect an overall outsourcing action with a large number of assessed red and yellow lights will be more costly and risky during its execution, even with due diligence in risk reduction.

What follows is a variation of Powell's stoplight scheme.³⁵

- a. Asset Specificity.

³³ The lower sigma (the marginal benefit of unproductive bargaining) and the higher gamma (the marginal cost of unproductive bargaining) for any particular activity, the lower the transaction costs of outsourcing.

³⁴ Powell, 2002.

³⁵ Franck, 2004.

RED. Source becomes specialized, with no close substitutes or competitors readily available. Example: only qualified supplier for a specific, highly-specialized task—such as suppliers of spare parts for aging weapon systems. High barriers to entry.

GREEN. Routine (non-specialized) goods or tasks; competitors or close substitutes readily available. Example: purchase of standard commercial items, such as paper clips and other office supplies. Low barriers to entry.

b. Complexity.

RED. A large-scale task covering a large geographic area. Complexity of task severely limits qualified bidders. Example: large-scale, complex IT support; such as NMCI.

GREEN. A simple, routine task or standard product. A large number of qualified bidders. Example: office supplies and dental services. (Even though dentistry is a complex activity requiring considerable skill and training, dental services are available throughout the general economy; that is, substitutes for contractor services are readily available.)

c. Length of Relationship.³⁶

RED. A long-term relationship, which strains ability to foresee problems during original contract negotiations. Complexity and asset specificity exacerbate this problem. Example: IT support, such as NMCI.

GREEN. Outsourcing is a one-time transaction, or can be structured as a series of one-time transactions. Example: purchase of office supplies.

d. Frequency.

RED. Specialized, complex task or service from which there is significant learning-by-doing. Incumbent contractor has significant competitive advantage over potential competitors. Example: contract maintenance for specialized aircraft, such as E-4s.

GREEN. Routine, standard task, service or product, in which a number of firms have significant expertise. Example: copy machine repair.

e. Time Sensitivity. (added)

RED. Quick performance of task or delivery of product is essential for satisfactory performance. Example: repair of combat aircraft, or warship subsystems.

GREEN. Quick delivery of products or accomplishment of task is not essential for satisfactory performance. Satisfactory performance can include some delays. Example: copy machine repairs.

³⁶ In a sense, the relationship lasts as long as the period specified in the contract, which means length of relationship issues can certainly be addressed in contracts. However, contracts must be agreed to by both parties, and the minimum length agreeable to both is determined in good part by the *nature* of the relationship itself.

f. Operational Significance. (added)

RED. Unsatisfactory performance significantly degrades operational capability or compromises safety. Example: repair of combat aircraft or warship subsystems.

GREEN. Unsatisfactory performance involves, at most, administrative inconvenience and longer time to accomplish routine tasks. No compromise of operational readiness or safety. Examples: delays in copy machine repairs and temporary lack of office supplies.

APPENDIX C. RULES FOR CONTRACT TYPES

Comparison of Major Contract Types (Fixed Price)					
	Firm Fixed-price (FFP)	Fixed-price Economic Price Adjustment (FPEPA)	Fixed-price Incentive Firm (FPIF)	Fixed-price Award-fee (FPAF)	Fixed-price Prospective Redetermination (FPRP)
Principal Risk to be Mitigated	None. Thus, the contractor assumes all cost risk.	Unstable market prices for labor or material over the life of the contract.	Moderately uncertain contract labor or material requirements.	Risk that the user will not be fully satisfied because of judgmental acceptance criteria.	Costs of performance after the first year because they cannot be estimated with confidence.
Use When...	The requirement is well-defined. Contractors are experienced in meeting it. Market conditions are stable. Financial risks are otherwise insignificant.	The market prices at risk are severable and significant. The risk stems from industry-wide contingencies beyond the contractor's control. The dollars at risk outweigh the administrative burdens of an FPEPA.	A ceiling price can be established that covers the most probable risks inherent in the nature of the work. The proposed profit sharing formula would motivate the contractor to control costs and meet other objectives.	Judgmental standards can be fairly applied by an Award-fee panel. The potential fee is large enough to both: Provide a meaningful incentive and justify related administrative burdens.	The Government needs a firm commitment from the contractor to deliver the supplies or services during subsequent years. The dollars at risk outweigh the administrative burdens of an FPRP.
Elements	A firm fixed-price for each line item or one or more groupings of line items.	A fixed-price, ceiling on upward adjustment, and a formula for adjusting the price up or down based on: Established prices. Actual labor or material costs. Labor or material indices.	A ceiling price Target cost Target profit Delivery, quality, and/or other performance targets (optional) Profit sharing formula.	A firm fixed-price. Standards for evaluating performance. Procedures for calculating a fee based on performance against the standards.	Fixed-price for the first period. Proposed subsequent periods (at least 12 months apart). Timetable for pricing the next period(s).
Contractor is Obligated to:	Provide an acceptable deliverable at the time, place and price	Provide an acceptable deliverable at the time and place specified in	Provide an acceptable deliverable at the	Perform at the time, place, and the price	Provide acceptable deliverables at the time and place



	specified in the contract.	the contract at the adjusted price.	time and place specified in the contract at or below the ceiling price.	fixed in the contract.	specified in the contract at the price established for each period.
Contractor Incentive (<i>other than maximizing goodwill</i>) ¹	Generally realizes an additional dollar of profit for every dollar that costs are reduced.	Generally realizes an additional dollar of profit for every dollar that costs are reduced.	Realizes a higher profit by completing the work below the ceiling price and/or by meeting objective performance targets.	Generally realizes an additional dollar of profit for every dollar that costs are reduced; earns an additional fee for satisfying the performance standards.	For the period of performance, realizes an additional dollar of profit for every dollar that costs are reduced.
Typical Application	Commercial supplies and services.	Long-term contracts for commercial supplies during a period of high inflation	Production of a major system based on a prototype	Performance-based service contracts.	Long-term production of spare parts for a major system.
Principal Limitations in FAR Parts 16, 32, 35, and 52	Generally NOT appropriate for R&D.	Must be justified.	Must be justified. Must be negotiated. Contractor must have an adequate accounting system. Cost data must support targets.	Must be negotiated.	MUST be negotiated. Contractor must have an adequate accounting system that supports the pricing periods. Prompt redeterminations.
Variants	Firm Fixed-price Level of Effort.		Successive Targets		Retroactive Redetermination

Comparison of Major Contract Types (Cost Reimbursable)

	Cost-Plus Incentive-Fee (CPIF)	Cost-Plus Award-Fee (CPAF)	Cost-Plus Fixed-Fee (CPFF)	Cost or Cost- Sharing (C or CS)	Time & Materials (T&M)
Principal Risk to be Mitigated	Highly uncertain and speculative labor hours, labor mix, and/or material requirements (and other things) necessary to perform the contract. The Government assumes the risks inherent in the contract -benefiting if the actual cost is lower than the expected cost-losing if the work cannot be completed within the expected cost of performance.				
Use When...	An objective relationship can be established between the fee and such measures of performance as actual costs, delivery dates, performance	Objective incentive targets are not feasible for critical aspects of performance. Judgmental standards can be fairly applied. ¹	Relating fee to performance (e.g., to actual costs) would be unworkable or of marginal utility.	The contractor expects substantial compensating benefits for absorbing part of the costs and/or foregoing fee	No other type of contract is suitable (e.g., because costs are too low to justify an audit of the contractor's indirect expenses).



	benchmarks, and the like.	Potential fee would provide a meaningful incentive.		or the vendor is a non-profit entity.	
Elements	Target cost Performance targets (optional) A minimum, maximum, and target fee A formula for adjusting fee based on actual costs and/or performance.	Target cost Standards for evaluating performance, A base and maximum fee Procedures for adjusting fee, based on performance against the standards.	Target cost Fixed fee	Target cost If CS, an agreement on the Government's share of the cost. No fee	A ceiling price A per-hour labor rate that also covers overhead and profit Provisions for reimbursing direct material costs
Contractor is Obligated to:	Make a good faith effort to meet the Government's needs within the estimated cost in the Schedule.				Make a good faith effort to meet the Government's needs within the ceiling price.
Contractor Incentive (other than maximizing goodwill) ¹	Realizes a higher fee by completing the work at a lower cost and/or by meeting other objective performance targets.	Realizes a higher fee by meeting judgmental performance standards.	Realizes a higher rate of return (i.e., fee divided by total cost) as total cost decreases.	If CS, shares in the cost of providing a deliverable of mutual benefit.	
Typical Application	Research and development of the prototype for a major system.	Large scale research study.	Research study.	Joint research with educational institutions.	Emergency repairs to heating plants and aircraft engines.
Principal Limitations in FAR Parts 16, 32, 35, and 52	The contractor must have an adequate accounting system. The Government must exercise surveillance during performance to ensure use of efficient methods and cost controls. Must be negotiated. Must be justified. Statutory and regulatory limits on the fees that may be negotiated. Must include the applicable Limitation of Cost clause at FAR 52.232-20 through 23.				Labor rates must be negotiated. MUST be justified. The Government MUST exercise appropriate surveillance to ensure efficient performance.
Variants			Completion or Term.		Labor Hour (LH)

¹ Goodwill is the value of the name, reputation, location, and intangible assets of the firm

Adapted from Contract Pricing Reference Guides (Vol. 4). Advanced issues in contract pricing matching contract type to contract risk. Retrieved from <http://www.acq.osd.mil/dpap/contractpricing/vol4chap1.htm>



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Development of Measures of Success for Corporate Level Air Force Acquisition Initiatives

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Abstract

The goal of this research is to suggest a framework for developing measures of success for corporate level Air Force acquisition initiatives. Because this research is exploratory, it focuses on only one initiative: the 2002 initiative “Focus on results, not process.” A qualitative method approach was used to suggest a four part framework. Through the review of literature, common steps for creating metrics were established and recurrent characteristics of good metrics were identified. Then interviews were conducted with acquisition practitioners who have experience with the initiative. Finally, those three parts were applied to the initiative as a case study and metrics suggested as a result.

This study gives Air Force leaders clear, implementable metrics that can be used as measures of success for the initiative, and provides recommendations to improve this initiative’s performance and that of future corporate Air Force acquisition initiatives. This study also gives leaders insight into whether or not this initiative and others like it are an appropriate and effective way to drive the changes they are meant to bring about. Finally, from a broader perspective, the framework used in this study can be used to develop metrics for other corporate level initiatives.

Introduction

Almost since its inception in 1947, the Air Force has sought to reform the way it procures weapon systems. Many factors involved in the weapon system acquisition process are external to the Air Force and out of its direct control (i.e., Congressional constraints, the pace of technology development, constantly changing world situations). However, self-imposed administrative hurdles are an internal factor that the Air Force can change in order to help improve its procurement practices.

To target the elements of the acquisition process within its control, the Air Force began implementing a series of acquisition reform initiatives in 1995. These initiatives, referred to as “Lightning Bolts,” were created in direct response to Air Force leadership’s growing concerns that it takes too long to put weapon systems in the hands of the warfighters (Department of the Air Force, 2003). Collectively, their purpose was to serve as the catalyst by which administrative changes are made in Air Force business practices (Senate Armed Services Committee, 2002). However, little is known about how to gauge the success of these initiatives. Many metrics have been suggested for gauging the success of acquisition reform attempts within the Department of Defense (DoD), but most of



the metrics remain slated for use only in individual acquisition program offices (Pope, 1997). No list of standard metrics exists, and there are no generally applicable and logical methods to measure the performance of acquisition reform initiatives today (Beamon, 1999; Pope, 1997). Accordingly, this project is designed to help better understand these initiatives and how to establish acquisition based measures of success.

Literature Review

This section provides the foundation for the study by addressing several relevant literature streams. First, the background and purpose of the acquisition reform initiatives are reviewed. Next, metrics are discussed, including general steps involved in developing metrics, attributes of good metrics, and how metrics can be applied to acquisition reform initiatives. This review identifies commonalities among theories of metric development that highlight common attributes of good metrics. Finally, a list of metrics, generated through a series of interviews, will be assessed against the characteristics of good metrics to construct a set of useable metrics for the 2002 initiative entitled “Focus on results, not process.”

Acquisition Reform Initiatives

On 27 February 2002, in an update to the Senate Armed Services Committee (2002) on the Air Force’s on-going acquisition reform efforts and progress, the Assistant Secretary of the Air Force for Acquisition, Dr. Marvin Sambur, reaffirmed the goal set for the Air Force by the President and the Secretary of Defense to transform the military and improve how it does business; specifically, the Air Force must reduce cycle times, improve its ability to estimate both costs and schedules, increase delivery speeds, and generally work to regain credibility with the war fighter.

In an effort to address senior leaders’ desire to improve speed and credibility, acquisition leaders released six acquisition reform initiatives in 2002; similar sets of initiatives had been released in groups of six to ten, approximately every two years since 1995. Two of the six initiatives released in 2002 were process oriented. One initiative, entitled “Focus on results, not process” encouraged streamlining existing acquisition processes, challenging those that do not add value, and getting rid of the processes that do not make sense. The second process initiative was designed to strengthen continuing process improvements and communication between the government and contractors by creating a knowledge pipeline. (Druyun, 2001; Senate Armed Services Committee, 2002)

The other four 2002 initiatives are people-oriented. These four initiatives sought to encourage cooperation between warfighters and acquisition practitioners during the development and incremental delivery of warfighting capabilities; to give managers a single point of contact, the Acquisition Center of Excellence (ACE) office to help them remove administrative and bureaucratic stumbling blocks, thus freeing them to be innovative; to change the ingrained culture of the acquisition workforce toward a bias for innovation; and to encourage leveraging the Air Force’s buying power in services through the creation of a Program Executive Officer (PEO) for service contracts.

This research will focus on the initiative arguably most closely linked with the corporate goal set for the Air Force to improve speed and credibility: “Focus on results, not process”. This initiative was designed to drive a “clean-sheet” approach to acquisitions by streamlining processes in order to remove non value-added steps (Senate Armed Services Committee, 2002). In other words, the initiative sought to free up the administrative hands



of acquisition practitioners to allow them to be as innovative as possible within the confines of the law. How well this and other initiatives are achieving their desired goal is an open question, and without valid metrics, it will remain so.

Metrics

The Metrics Handbook developed by the then Air Force Systems Command (1991) defines metrics as meaningful measures that allow action to be taken. Similarly, Antanitus (2003) calls metrics items you would like to measure. Metrics emphasize the customer, support organizational objectives and goals, facilitate process understanding, and encourage continual improvement of how business is done (AFSC, 1991).

Metrics improve performance (Antanitus, 2003; Buchheim, 2000; Rummler and Brache, 1995) by indicating how well an organization is performing (Goett, 2003; Klapper, Hamblin, Hutchison, Novak, and Vivar, 1999; Lambert and Pohlen, 2001; Milliken, 2001). Metrics not only examine how an organization is performing (Milliken 2001), but more importantly, should help it perform better (Hammer, 2001).

Metrics are used to improve performance and properly structured metrics can drive superior performance. Keebler et al. (1999) discovered a great disparity in levels of organizational performance and found the most important factor driving superior performance among the organizations in their study was the presence of well-utilized and properly structured measurement programs. Inadequately structured metrics, on the other hand, can drive the wrong behaviors and even result in dysfunctional behaviors (Neely, Richards, Mills, Platts, and Bourne, 1997).

Additional evidence of how the use of metrics has been shown to improve performance is seen in the literature on goal setting (see, for example, Latham and Yukl, 1975; Latham and Locke 1979; Locke 1968; Locke, Shaw, Saari, and Latham, 1981; Locke 1982). a significant amount of data attests to the presence of increased performance when goals are set, and, therefore, when metrics are used. Within the context of goal-setting, metrics are the feedback mechanism by which progress toward organizational goals is measured (Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, 1999). For example, the Commander's Initial Guidance on improving speed and credibility states that the overall goal is to shorten the time it takes for decisions and getting more capable weapon systems out to the warfighter by a factor of four (Department of the Air Force, 2003). Correspondingly, the metric to determine if that goal is met will be cycle time.

In addition to metrics' importance because of improved performance, Keebler et al. (1999) point out that measures aid companies in determining how to remain competitive and confirm the value customers place on their services. And the underlying truth within the axiom that what gets measured gets attention is yet another reason to use metrics (Eccles, 1991; Osborne and Gaebler, 1992).

If metrics are important, what makes a good metric? According to Clark and Wheelwright (1994:262), there are two types of measures: results measures, which tell a team where it currently stands in its attempt to reach a goal, rather than how it got there or what it could do differently; and process measures which look at activities and tasks within an organization that produce given results. Also, metrics can be expressed both qualitatively and quantitatively (Beamon, 1999). Quantitative metrics are frequently



preferred because qualitative metrics, like “poor,” “fair,” and “good,” are vague and hard to use in a meaningful way (Beamon, 1999). However, quantitative metrics may not adequately discuss a system’s performance and, as a result, may be just as vague (Beamon, 1999). It should not be assumed that specific quantitative goals, and, in turn, metrics, are inevitably beneficial; some areas where results are more difficult to measure may require qualitative goals, and, in turn, qualitative metrics (Locke, 1978). The decision between qualitative and quantitative metrics depends upon the nature of the system for which the metrics, or goals, are being established.

Steps to Create Metrics.

By comparing the numerous methods for systematically developing metrics that exist within the literature, this research found that nearly all of the methods share three common steps which will later be discussed. Of the literature reviewed, twelve authors presented thirteen general frameworks for creating metrics (AFSC, 1991; Antanitus, 2003; Brown, 1996; Buckheim, 2000; Clark and Wheelwright, 1994; Eccles and Pyburn, 1992; Evans and Lindsay 2002; INCOSE, 1998; Keebler et al., 1999; Mentzer and Konrad 1991; Pinker, Smith, and Booher, 1997; Rummler and Brache, 1995). The number of steps involved in each framework ranged from three steps up to eleven steps. For example, Clark and Wheelwright (1994) suggest a four step method: a) define factors critical to customer satisfaction; b) map cross-functional process through which results are obtained; c) identify capabilities and tasks necessary to complete process successfully; and d) design measures to track those capabilities and tasks. Rummler and Brache (1995) recommend a similar four step sequence: a) clearly establish the most important outputs of the process, job, or organization; b) for each output, establish the “critical dimensions” of performance; c) create measures for every critical dimension; and d) create standards, or goals, for each measure. In contrast, Eccles and Pyburn (1992) suggest a five step process that does not share the three steps found to be common among the other authors: a) choose non-financial measures that will compliment financial measures, determine relationships between them, and create firm’s business performance model; b) establish methodology to be used to take the measures; c) select the frequency and layout of performance measurement reports; d) adjust how personnel are compensated and evaluated to encourage desired behavioral changes that will improve activity performance; and e) realize a key element of performance measurement system is that it will evolve with time as managers grow and increase their knowledge of measures’ relationships to one another and as conditions change.

No empirical evidence was found within the literature to suggest that any one particular method was better to use than any other. Many differences exist among the authors’ approaches, but three basic steps remained common among eleven of the thirteen frameworks examined (INCOSE, 1998). First, establish a starting point upon which to base the metrics; determine what you want to measure. Second, identify the most important elements of what you want to measure. Third, create specific metrics for those critical elements so as to improve the performance of the item being measured. If metrics are created by systematically following these three general steps and they possess the attributes of good metrics they will be properly-structured metrics and will have the potential to drive superior performance (Keebler and others, 1999).



Attributes of Good Metrics.

Certain characteristics distinguish good metrics from bad ones and well-designed metrics possess those good characteristics. Fourteen authors in the literature describe forty-three distinct attributes that good metrics possess (AFSC, 1991; Antanitus, 2003; Beamon, 1999; Brown, 1996; Buckheim, 2000; Cohen 2003; Evans and Lindsay 2002; INCOSE, 1998; Kaplan 1991; Keebler et al., 1999; Mentzer and Konrad 1991; Milliken, 2001; Pinker, Smith, and Booher, 1997; Rummler and Brache, 1995). Beamon (1999), for example, says that good metrics have six characteristics: consistency with organizational goals, inclusiveness of pertinent aspects, measurability, meeting of customer goals and values, relate to strategic goals and mission of organization, and universality. In comparison, Buchheim (2000) describes good metrics as having eight characteristics, only one of which is common with those cited by Beamon (i.e., relating to strategic goals and mission). According to Buchheim (2000), good metrics: have a defined sensor that gathers and records data, like an automated test station data file or a clerk; have a defined unit of measurement (e.g., hours per widget produced); are meaningful to the customer; measure results versus process (e.g., measure the level of skill demonstrated using a widget versus the number of days spent attending training sessions); have a regular frequency with which reports and measurements are done (e.g., monthly average failure rate); are simple to use; and are understandable. Evans and Lindsay (2002) agree with both Beamon and Buchheim that good metrics relate to the strategic goals and mission of the organization involved, but also state that good metrics are actionable and useful.

Summarizing the commonalities among the various lists of attributes, six authors claim metrics should relate to the organizational mission and strategic goals, five suggest simplicity is an important quality of metrics, and five state good metrics are meaningful to customers. Four authors point out metrics should be understandable and derivable from economically collectible data (i.e., cost effective). All other attributes are common among three authors or less.

Application of Metrics to Acquisition Reform Initiatives.

The military acquisition community manages and oversees the activities involved in the procurement of weapon systems, from initial development and procurement, through delivery to the war fighters and to the end of a weapon system's life cycle when it is retired. This comprehensive system suggests a supply chain perspective is appropriate for analyzing the weapon system acquisition and management process (Klapper et al., 1999; Monczka et al., 2004).

Metrics appropriate for acquisition reform enable an organization to assess reform initiatives' effectiveness and implementation on both acquisition programs and the acquisition reform process itself (Pope, 1997). Groups within the DoD have proposed various metrics to measure acquisition reform, but most metrics have been specific to individual acquisition programs (Pope, 1997) and no systematic approach to performance measurement or standardized set of metrics for acquisition reform initiatives exists (Beamon, 1999; Pope, 1997).

In an effort to address the lack of standardized metrics for acquisition initiatives, the Acquisition Reform Benchmarking Group (ARBG) was established by the DoD in 1996 to help measure progress within the arena of acquisition reform (Pope, 1997). Pope (1997) determined that the findings of the ARBG divide metrics into three levels: program, subordinate, and enterprise. Metrics at their most basic level measure elements within



individual acquisition programs (DiCicco, 2003). Subordinate metrics measure factors that feed into the highest level of metrics, which are enterprise metrics. Enterprise metrics measure the efficiency of overarching or generalizable processes that should be measured across the whole Air Force (DiCicco, 2003; Pope, 1997). Enterprise metrics include cost, schedule, performance, and training metrics. The acquisition initiative this research focuses on pertains to enterprise-level acquisition and the metrics this research will recommend be used to assess that initiative are enterprise level metrics.

Pope (1997) found that metrics can also be categorized by the three types of activities that they measure, as defined by the 1995 Process Action Team (PAT) for contract administration reform: go/no-go, activities, and behavioral changes. Go/no-go metrics show whether or not an activity has taken place. Activity metrics illustrate how extensively an action is occurring. And behavioral change metrics assess whether actions are creating the desired change in behavior or results. This research seeks in large part to determine whether or not the use of the acquisition initiative of interest is an effective way to bring about the desired changes in the acquisition practitioners' behavior.

Methodology

Based on the nature of the research question, a qualitative approach was used to guide the research project based on the procedures outlined by Creswell (2003). Data was collected through a series of semi-structured interviews. After the interviews were transcribed, the transcriptions were broken down into statements and analyzed for common themes. Specifically, the interviews were designed to generate a list of metrics that can be used to measure the reform initiative of interest and to determine the extent to which this initiative was facilitating desired changes.

Interview Sample.

In 2001, Acquisition Centers of Excellence (ACE) were established for the Air Force, Air Force Materiel Command, Air Force Product Centers, and Air Logistic Centers to lead acquisition reform efforts (New Acquisition Center Provides Warfighting Capabilities, 2001; Lightning Bolts, 2004). Part of their duties is to oversee the implementation of the major acquisition reform initiatives. As a result, the ACE offices have helped system program office (SPO)³⁷ leadership understand and implement the initiatives. Therefore, in this research, members at the ACE offices and various system program offices (SPOs) within the Air Force's Product Centers and Air Logistics Centers were interviewed. To further broaden the research sample, individuals holding various acquisition related positions within Air Combat Command, Air Force Space Command, and Air Staff were also interviewed. Modeling Carter and Jennings (2002), the sample interviewed was chosen with the intent of getting a high degree of variation among managerial levels in order to get a higher range or scope of data.

The ACE personnel were asked to identify interview participants, within the SPOs, who have experience with the initiative of interest. Of the fourteen Center ACEs queried for assistance, two provided contact information for interview participants. The two respondent

³⁷ The Air Force recently renamed its acquisition organizations to reflect better the more standard military terminology of wings, groups, and squadrons. This paper retains the previous terminology of program offices and the like, because readers are likely to be more familiar with these names.



Center ACEs were from separate locations; participants from Acquisition Category (ACAT) one and two programs were identified at one location and from ACAT three programs at the other location. ACAT describes program size and dollar amount and ranges from one, being the largest and most expensive programs, to three, being the smallest and least expensive. Six Center ACEs gave negative replies (three of which were initially non-respondent, but gave negative replies when asked again) and cited several reasons why: individuals at their location had no experience with the initiative of interest; they sent a message out to SPOs asking for participants and got no replies back; due to the nature of the mission at their location (e.g., a test and evaluation organization) they did not use the initiative of interest; they never received the initial request from the SAF/ACE asking for assistance with the research; and since their location was neither a Product nor Logistics Center (e.g., a Test Center), they thought the request for research assistance did not apply to them. Some Center ACEs cited more than one reason for their negative replies. The six remaining Center ACEs were completely non-responsive even after being queried a second time.

The low Center ACE response rate indicated a broader interview sample was needed and that individuals with acquisition experience from Air Combat Command, Air Force Space Command, and Air Staff should be included among interview participants. Additional participants were identified with the assistance of the SAF/ACE, through interview participants recommending that other specific individuals be contacted for interviews, and through personal contacts of the researcher. A total of twenty five participants were identified and interviewed, but only twenty three interviews were usable; nineteen oral interviews were successfully transcribed, two oral interview recordings were inaudible and subsequently unusable, two interviews were recorded using only notes taken during the interviews, and two interviews were conducted via email.

Interview Correspondence.

Potential interview participants were identified and then contacted to determine their willingness to participate. The interview questions were provided prior to conducting the interviews so that participants could prepare, in hopes of making the interviews more efficient and effective. After interview candidates were identified and invited to participate, each was contacted via email or telephone to schedule an interview time. Prior to the scheduled interviews, each participant was contacted to confirm his or her availability for the interview. Then, the interviews were conducted face-to-face and over the telephone at scheduled times, and using email. Notes were taken during each verbal interview, and interviews were recorded and transcribed (with the interviewee's permission) whenever possible. All interviewees were promised anonymity.

Interview Method.

The interviews included open-ended items, allowing participants to go in different directions. However, in this research, a semi-structured interview approach was used in order to address the topics of interest about participants' use of the focal reform initiative, within the interview time constraints. A semi-structured interview enabled the research to follow standard questions while allowing the latitude to include a few tailored questions to probe or clarify a participant's reasoning. (Leedy and Ormrod, 2001)



Analysis Technique

The qualitative data collected was analyzed using Creswell's (1997) data analysis spiral. Using this spiral, data was reviewed multiple times while going through the following steps. First, the data was organized using a computer database, and broken into smaller text units (i.e., sentence and individual words). Second the data was perused for potential themes and categories. Third, each individual datum was classified using the major themes. Finally, the data was integrated and summarized.

Two major strategies were employed to ensure validity. First, peer debriefing of experienced acquisition practitioners familiar with this area of research helped ensure the accuracy of the findings and to make the explanation of this research clearer for an outside audience (Creswell, 2003). Secondly, following Isabella (1990) and Creswell (2003), external auditors were used to review the entire research project. As part of the qualitative data analysis, recurrent themes were identified and interview data categorized accordingly. Non-acquisition and acquisition professionals who were new to the research project categorized interview statements under the themes they thought were appropriate matches. The independent categorization provided by the auditors validated the primary classification and synthesis of the data by the research team.

Data Analysis

This section discusses the analysis of the data, which revealed many patterns and themes that address the overall research problem.

Interview Participants

Interviews were conducted with officers and civilians from Air Combat Command, Air Force Materiel Command, Air Force Space Command, and the Air Staff. Individuals ranged in rank from GS-12s to Senior Executive Service (SES) members and General Officers and held a variety of acquisition positions from System Program Office (SPO) level program workers, to Program Executive Officers (PEOs) and Center Commanders, to staff positions with the Assistant Secretary of the Air Force. Their time in federal service ranged from five years up to thirty one years. The high degree of variety in participants' managerial levels and areas of expertise provided a high range or scope of data (Carter and Jennings, 2002).

For purposes of maintaining participant confidentiality, GM-15s, GS-15s, and Senior Executive Service members (excluding those within the Air Staff), and System Program Directors, Program Executive Officers (PEOs), and Center Commanders who participated in this research will be categorized as "middle management." Interview participants referred to this grouping of people as middle management, to Assistant Secretary of the Air Force equivalent positions and above as "senior leadership," and to Deputy System Program Director equivalent positions and below as "SPO level workers." Most so-called middle managers, and some so-called workers, are actually relatively senior, experienced personnel; the categories represent a self-classification by the participants of their positions relative to other participants' positions.

Analysis Overview

Modeling Isabella (1990), interview participants' responses to each interview question were systematically and carefully examined to identify both recurrent themes and



unique. Every interview transcript was reviewed and sections of the interviews were excerpted verbatim and typed on separate pieces of paper to illustrate the nucleus of each individual's statements (Isabella, 1990). After excerpts were perused, they were classified into recurrent themes and categories (Creswell, 2003; Isabella, 1990). Roughly seven hundred excerpts were recorded. Category coding accuracy was ensured using external auditors (Creswell, 2003; Isabella, 1990). Reviewers' results provided reasonable verification of coding procedure accuracy (Creswell, 2003; Isabella, 1990). The patterns and themes revealed through this coding are described below in greater detail for each interview question.

Suggested Metrics for "Focus on results, not process" Initiative Implementation.

Two interview questions directly addressed metrics for the initiative of interest. Interview participants were asked what metrics they would use to measure the results the initiative was meant to bring about, and then later in the interview participants were asked how they would know if they were succeeding at implementing the initiative. Out of participants' responses, five main categories of metrics were recurrent: schedule, customer satisfaction, cost, performance, and credibility. The remaining interview excerpts for these questions that did not seem to fit into a particular category were placed in a miscellaneous category.

The theme most identified by participants was schedule, or acquisition program baseline, which refers to the lengths of time a program has set to accomplish various tasks. This category, which relates directly to Sambur's (Senate Armed Services Committee, 2002) call for improved speed, also included a sub-category of cycle time, meaning the length of time from identifying a need for something until it is delivered. Cycle time, in turn, included two subcategories. Capability based cycle time refers to the amount of time between the warfighter stating his need for a new capability and that capability being delivered. Documentation based cycle time refers to acquisition lead-time or the time it takes to complete a document related activity, e.g., contract negotiation and award. Seventy four percent of participants identified schedule as a metric category for the initiative of interest.

Customer satisfaction with the product, process, or service being provided was the second most frequently named metric category. In the participants' view, customer satisfaction also encompasses a sub-category of expectation management. A large part of how satisfied the customer is depends on whether they received what they were expecting. Sixty one percent of participants named customer satisfaction as a metric category.

Cost and performance were the third and forth most identified themes. Cost is self explanatory; it deals with activities related to money. This theme occurred among thirty nine percent of participants. Performance, how well a program performs to specifications and expectations, was the fourth most recurring theme for these interview questions. Both customer satisfaction and performance address expectations; of the two, performance is the more direct comparison against expected capability, and customer satisfaction addresses a more comprehensive assessment of all customer expectations. Twenty six percent of participants suggested metrics that fit into this category.

Credibility was the fifth category of participant interview responses. Credibility for the acquisition workforce would mean that their customers, mainly the warfighters, would believe what they tell them and find them trustworthy. This also ties in with Sambur's (Senate Armed Services Committee, 2002) call to improve credibility; the acquisition



community has to deliver what they say they are going to deliver. However, the occurrence of this theme among only seventeen percent of participants does not seem to support Sambur's push for improved credibility; this indicates that not many people see measuring credibility as a way of telling if this initiative is succeeding. In contrast, the frequent recurrence of schedule among seventy four percent of participants does offer support for Sambur's call for speed.

Meaning of 2002 Lighting Bolt "Focus on results, not process" Initiative.

Interview participants were asked what they thought the initiative of interest meant. Interview participants included individuals who helped to draft the initiative, one of whom stated the following about what the initiative was intended to mean:

Too many people within the acquisition community focus on completing processes (reports, assessments, checklists, etc). The Lighting Bolt aimed to cause people to look at the result intended by the process and to make a judgement of whether the activity planned actually furthers the opportunity for success. Success isn't getting through the process – its delivering a needed capability to the warfighter!

A variety of other responses were provided by participants and then grouped by the themes that emerged. The top five responses were:

- Focus on the end customer not the acquisition process itself; support the customer
- Does what we are doing make sense and does it add value? If not, get rid of it or waive it; remove the unnecessary steps
- Freeing people up
- Focus on getting the product out; effects based or outcome based acquisitions
- Want results not just process

Desired Results or Outcomes of Initiative.

Next, participants were asked what they thought were the desired outcomes or results that the initiative was trying to accomplish. Multiple themes were identified from the interview data, the first of which occurred within eleven excerpts among nine respondents, the second from ten excerpts between eight respondents, and the remainder from five excerpts among four respondents or less. The top five responses were:

- Support the Agile Acquisition strategy; provide capability in a timely way without getting bogged down in the processes
- Change people's way of thinking; be creative, innovative, and use common sense
- Get people to think about the outcome not the how
- Promises made, promises kept
- Roadblocks exist to accomplishing initiative outcomes from 1) middle management, 2) SAF/AQ staff and other services, and 3) contracting

Appropriateness of Initiative Goals.

Participants were also asked if they thought the goals of the initiative were appropriate. Based on their understanding of what they thought the goals or outcomes of the initiative to be, twenty of the twenty three participants agreed the goals were



appropriate. However, when asked if they felt using this initiative was the most appropriate way to accomplish the goals that it was meant to accomplish, several participants offered various criticisms of the initiative, including inadequate education about its motive, a perception that the initiative was successful only while its champion ran Air Force acquisition, and a general lack of top management support beyond the champion.

Most Important Aspects of the Initiative.

The interview participants were then asked what they considered to be the most important aspects of the “Focus on results, not process” initiative. Four main themes were identified within the data and were close in frequency of occurrence among participants. Organizational culture was the most recurring theme; nine excerpts from six participants reflected this theme. Participants stated that an entrepreneurial mindset was the next most important aspect which includes, but is not limited to, becoming creative, not being risk averse, taking bold steps to challenge the status quo, and thinking differently. Seven interview excerpts among seven participants noted this aspect. Responsiveness to the customer was the next most frequently seen theme with six excerpts among five participants. Lastly, five excerpts from four participants shared the theme of communication.

How Participants Heard about the Initiative.

Next participants were asked how they had actually heard of the initiative. Four participants said that they had not heard of the “Focus on results, not process” concept as a formal initiative until they were contacted about this research project; but, based on their interview responses they had actually already been carrying out the intent of the initiative within their jobs. Those participants included two SPO program managers, a Deputy SPO Director, and an Air Staff member. Among those participants who had heard of the initiative, the sources from which they learned of the initiative were varied. The most frequent source of introduction to the initiative was through participants’ chains of command and normal information distribution channels; seven excerpts from seven participants shared this theme. The next most recurring theme was direct involvement with Darleen Druyun, the originator of the initiative. Six excerpts from five participants shared this theme. Three excerpts from three participants noted direct contributions to writing the initiative. And the three remaining themes observed from single excerpts among individual participants were acquisition reform training, Sambur’s (Department of the Air Force, 4 February 2003) letter to the acquisition community introducing the initiative as part of the new push for improved speed and credibility, and working in an Acquisition Center of Excellence (ACE) office.

Next Step in “Focusing on Results”.

In addition to being asked to explain how they had heard about the initiative, participants were asked what the next step should be in order to get the acquisition community to actually implement the objectives of the initiative and really focus on the results. There were as many responses to this question as there were interview participants. The most frequent theme within the interview responses for this question was seen within six excerpts shared among four participants. The second most frequent theme came from six excerpts among three participants. The next two most frequent themes were seen in three excerpts from three participants. All of the other themes were shared by only two participants or less. The top four responses were:

- Change the acquisition workforce culture
- Apply the initiative to the processes that support Evolutionary Acquisition



- Training and education
- Expectation management with the warfighters and Air Staff, and in turn Congress

Organization Implementation of the Initiative.

After stating what they thought would be the next steps to take in order to get people to accomplish the goals of the initiative, participants were asked how their organizations were implementing the initiative. The themes from the data describing organizational use of the initiative are listed below. The most frequent theme incorporates seven excerpts from five participants who are members of various Acquisition Center of Excellence (ACE) offices; the second most frequent theme was from seven excerpts among three participants; and the third most frequently occurring theme was shared by four excerpts from four participants. These top three themes were

- ACE offices assist programs to challenge burdensome processes and try to influence people to use the philosophy of the initiative
- Stress full participation of Integrated Product Teams (IPTs) and ensure IPTs include the warfighters, contractors, and contracting officers
- Rewrote Air Force Instructions and Air Force Federal Acquisition Regulation Supplements and other guiding documents to free up people

Most participants indicated they were implementing the initiative in some way, but several said they were not. Most notably, several middle management participants said they were not actively implementing the initiative because from their perspectives Air Force acquisition and sustainment were process oriented than product oriented. They referred to required participation in lecture series and workshops by renowned process re-engineering advocate Michael Hammer (Hammer, 2001:i). Another participant stated that they would not remove non-value added acquisition processes because they would not challenge the Federal Acquisition Regulation without a lawyer. And one other participant said they were having difficulty implementing the initiative.

Participants' Roles in the Development or Implementation of the Initiative.

Not only were participants asked how their organizations were implementing the initiative, each participant was asked what his or her specific role was in either the development or implementation of the initiative. The most recurring theme, from fourteen excerpts among eight participants, was that participants acted as enablers for their teams by challenging their teams to use the initiative; running interference for their teams when their attempts to implement the initiative met resistance; and developing and maintaining good relationships with people involved with the acquisition. All other themes came from three excerpts from three participants or less. The top five themes were:

- Being an enabler for your team
- Developer or author of the initiative
- Endorser and advocate of the initiative
- Had no role in the development of the initiative
- Provide advice to senior leadership on ways to implement the initiative

Support for Organizational Implementation of Initiative.

After participants were asked about their roles in the development and implementation of the initiative, they were asked several questions about the level of support



they are receiving in their attempts to implement the initiative. The first of these questions asked what kind of support participants' organizations were getting as they try to use the initiative. The most recurring theme that was seen in responses to this question came from eighteen excerpts given by thirteen participants. The other themes were expressed in three excerpts among three participants or less. The top five themes were:

- Top down support
- ACE help in planning for program events
- Contractor support
- Initiative training; risk management training and Discovery Map training
- Being left alone and trusted to go implement the initiative is the best support

However, several negative themes about the level of support organizations were receiving arose from the responses of seven participants.

- No support is being given
- The bureaucracy is fighting implementation of the initiative
- Senior leaders empowered the workforce to go out and implement the initiative, but they are not preaching it enough themselves; need strong, consistent advocacy
- Headquarters puts the initiatives out but does not have to live with them

Support for Individual Implementation of Initiative.

The next support related question dealt with whether or not they felt they were getting the support they needed to implement the initiative. Over sixty five percent of the participants said they were receiving the support they needed to implement the initiative from those within their chain of command and from those areas within their control. However, thirty percent of participants said they were not getting the support they needed from those who are outside of their chain of command but can still influence their ability to implement the initiative. Five percent of participants were undecided. Participants noted that they were not getting support from Headquarters Air Force (HQ USAF), Air Staff, or the Office of the Secretary of Defense. The need for consistent, repeated, vocal support from senior Air Force leaders and the need for buy-in from people and processes outside of the immediate Air Force chain of command were recurring themes among the participants.

Organizational Support for Individual Implementation of Initiative.

Participants were also asked how their organizations were supporting them in their attempts to put the initiative into action. The theme of support and encouragement being provided by leadership within participants' direct chains of command was noted among twelve excerpts from eleven out of twenty three participants. Three other participants, including two middle management members, said they received support from their organizations by being trusted to do the job and being left alone to do it. Three excerpts from one participant called out strong support from the ACE offices as an avenue of organizational support. Another participant said they were getting support from their organization by virtue of having no kick-back from SPO members which indicated that the SPO members have accepted the challenge for their organization to implement the initiative. The final theme that arose out of excerpts for this question was from a participant who twice stated that they were not seeing leaders at the Senior Executive Service (SES) and General



Officer level engage enough in the drive to use this initiative; the participant considers leaders' involvement to be one of the most important tools they need to do their job.

Initiative Implementation Success Stories.

After participants were asked about the level of support they were receiving in their attempts to utilize the initiative, they were asked if they had heard of any success stories or failures at using the initiative. Eleven of the twenty three participants said they could cite no specific examples of success stories, but eleven other participants did provide examples of what they considered to be successes. The success stories were grouped into two categories: process level successes and program level successes.

Process level successes are ways the initiative of interest has been used to remove non value-added processes and which can be repeated within program offices across the entire Air Force. Participants cited several examples, such as including a source selection plan in a System Acquisition Management Plan in order to get approval for both at the same time; incorporating a Price Competition Memo (PCM) in a Proposal Analysis Report (PAR) which reduced time because now the same pricing structure can be used for both the PAR and PCM; successfully challenging the need for Mission Need Statement (MNS) and Operational Requirements Document (ORD) on a common computer purchase and saving an estimated six months of work to do the MNS and ORD; delegation of contract approval authority down to various base level personnel, so that people now rarely have to go to higher headquarters for approvals.

In addition to process level success stories, several weapon system programs were recognized by participants as examples of how the initiative can be utilized successfully. One such program is the Crystal Modification Program. The organization running that program was able to go and influence the Army and Navy to combine functionalities of boxes where it made sense to do so and reduce the footprint, and, in turn, reduce the development costs and infrastructure costs. Several other programs were also identified as success stories because of how they kept their focus on the results being delivered to the warfighters and how they did not get bogged down in the acquisition process itself. Programs like Global Hawk, Micro Impulse Radar, Patient Support Pallet, and the weaponization of Predator are additional examples that participants considered success stories of how the initiative of interest can be used.

Initiative Implementation Failures.

Forty three percent of interview participants indicated that they had not heard of any specific examples of failure at using the initiative, though several others did identify process-level failures. One participant discussed how the Air Force's process for reprogramming funds, which allows money to be used for programs other than what it was originally slated for, does not enact the initiative. The impression among the Air Force workforce is that Congress is why it takes too long to approve reprogramming. The participant's office checked and found out that Congress only takes thirty of the hundred and fifty-eight day cycle to reprogram funding; the rest is taken up by the Air Force. So if money has to be reprogrammed above certain approval thresholds, it takes an average of a hundred and thirty days just to process the request through the Pentagon.

Another process level failure example involved an attempt to do a zero baseline of all work in a SPO at Electronic Systems Center. This exercise was originally designed to challenge the value-added contribution of every activity that the program office was doing by



forcing each activity and report to justify its contribution. SPO personnel were not interested in doing it. This was clearly a failure at implementing the initiative. After participants were asked about successes and failures at using the initiative of interest, they were asked questions about acquisition reform initiatives in general.

Being Successful at Implementing Any Acquisition Reform Initiative.

The last two interview questions were applicable to acquisition reform initiatives on a broader scale. The first of these two questions asked participants what they think it takes to be successful at utilizing any acquisition reform initiative. A range of themes emerged from their responses. The most frequently occurring theme was seen among eleven interview excerpts from seven participants. The second most frequent theme came from seven excerpts among seven participants. The third most frequent theme was common among five excerpts from five participants. And the fourth most common theme was from six excerpts among four participants. The top four themes were:

- Consistent message from the top
- Senior leadership buy-in; support and advocacy for initiative from senior leaders
- Be very specific in what the initiative says and in what is expected of those who use it
- Behavior of leaders has to reinforce philosophy behind the initiative

Important Elements of an Acquisition Reform Initiative.

Lastly, after interview participants were asked about what they considered to be the keys to successful initiative implementation, they were asked what was important to them in any acquisition reform initiative. Many of the themes that emerged from the data mirrored the characteristics of good metrics found within literature. The most recurring theme was from six interview excerpts among five participants. The next three most recurring themes were each common among four excerpts from four participants. The other themes produced came from five excerpts from three participants or less. The top four themes were:

- Focus on the mission of the Air Force and getting something to the warfighters
- Be beneficial to the acquisition grunts and the end users
- Makes sense
- Follow through; see it through to the end

Summary

After the interview data were carefully examined using methods modeled after Creswell (2003) and Isabella (1990), excerpts from participants' responses that represented the core of their answers to each question were grouped by the themes that emerged. Those themes revealed participants' opinions about the kinds of metrics they would use to measure the "Focus on results, not process" initiative's success, the meaning and goals of the initiative, the next step in achieving the initiative's goals, how they heard about it, the kind of support initiative implementation is receiving, successes and failures at initiative utilization, and how to make generic initiatives successful. This analysis will serve as the basis for several conclusions and recommendations discussed in the final section of the paper.



Conclusions & Recommendations

This research has attempted to help senior Air Force leaders build a framework for developing measures of success for corporate level Air Force acquisition initiatives. This section discusses the conclusions and recommendations based on the analysis.

Conclusions

Five conclusions were drawn from the interview data. First, a breakdown in communication about what the initiative meant occurred throughout the acquisition workforce; no consistent definition for the initiative was found among participants except among the participants who helped author the initiative and those who work in ACE offices. Many people took the initiative to mean “if the acquisition process in question was not a law, then break it”. The authors of the initiative, however, stated the intent was for people to challenge non-value added processes with well-supported waiver requests.

Secondly, disconnects exist between the middle management level and the other management levels on several fronts. Middle management shared a unanimous view on what the initiative was intended to accomplish, but that view differed from the view that senior leaders and SPO level workers shared. Senior leaders provided guidance on how to apply the initiative and on what the initiative means in the form of policy letters, directives, and briefings (Department of the Air Force, 4 February 2003; Department of the Air Force, 10 July 2003; Senate Armed Services Committee, 2002). In addition, SPO level workers provided numerous examples of success stories at implementing the initiative within their program offices, showing a clear understanding of the initiative and active use of it. However, middle management thinks the initiative is a “dead horse,” and cited a countervailing emphasis on process reform (“Hammer training”) as confusing the focus. Finally, a possible confound is that middle management’s disconnects with the other management levels may be due in part to some bias towards the initiative originator.

The third conclusion is that participants perceive that administrative hurdles to implementing the initiative are being put up by organizations and agencies outside of participants’ chains of command. Participants clearly stated that they are getting the support they need from their immediate bosses, but that there are obstacles from outside organizations and agencies; for example, added oversight from Congress, having to work with the Department of Defense and other services, and having to get approvals from people outside of their decision chain of command. Thirty percent of participants stated that those outside their chain of command, who can still influence their level of success at implementing the initiative, are not providing the support participants need. Numerous participants also included the Office of the Secretary Of Defense (OSD) among their biggest perceived roadblocks.

A fourth conclusion was that differing perceptions exist about to whom the initiative applies. According to some participants, the dubbing of the initiative as an acquisition reform initiative led people within the requirements arena (e.g., Air Combat Command), people in the testing community, and those in the logistics and weapon system sustainment community to think the initiative was only geared towards weapon system acquisition offices. The negative responses from many of the people approached to participate in this research cited the point that they did not think the initiative applied to them as the reason they could not help with this research; Test and Evaluation Centers, Air Logistics Centers, and an Air



Force Space Command System Program Office (SPO) did not participate in this research for that reason.

The final conclusion drawn is that using an initiative like this may not be the most effective way to accomplish the desired behavioral change. Just sending out an initiative and leaving it up to the workers in the acquisition trenches to figure out how to apply it will not cut it. The need for leadership and people's fears of change and failure need to be addressed. Participants, including the middle management personnel, consistently said that senior leaders need to be more engaged and regularly vocal about the importance of things like the initiative for it to be successful. After conclusions were reached, recommendations were developed using both the data analysis and literature review findings.

Recommendations

These five conclusions suggest several recommendations. The first recommendation of this research will only address the metric category of customer satisfaction because the categories of schedule, cost, credibility, and performance have been previously addressed by other Air Force agencies and because cost, schedule, and performance metrics are already broadly used across the Air Force (Air Force Inspection Agency, 2003:84).

This research recommends the use of customer satisfaction metrics to measure the success of the "Focus on results, not process" initiative. Customer satisfaction is described as the extent to which a process or product meets a customer's expectations (Kotler and Armstrong, 2001; Naumann and Jackson, 1999; Zeithaml and Bitner, 2006). Customer satisfaction is the key to organizational success (Gibson et al., 2003). No matter how precisely a schedule is maintained, how much cost savings are realized, how credible the end customer thinks the acquisition community is, or what exceptional performance a weapon system or process has, if the customer is not satisfied with the result, the acquisition community has failed. While multiple customer satisfaction metrics could apply and one size does not fit all (INCOSE, 1998:9), the following suggested metrics could prove very useful.

A suggested metric for schedule is timeliness (Ellis and Curtis, 1995; Hayes, 1992). Suggested metrics for performance are reliability and perceived quality (Ellis and Curtis, 1995; Naumann and Jackson, 1999). And a suggested metric for the area of credibility is responsiveness (Ellis and Curtis, 1995; Hayes, 1992; Naumann and Jackson, 1999). A customer satisfaction metric for cost is not suggested because, according to Hammer (2001), it tells very little if anything about the business. The list of metrics is general since the attributes of each dimension are very product specific, meaning the metrics should be tailored for a better fit depending upon what product or process they are applied to (Naumann and Jackson, 1999).

Expand Innovation Education for the Acquisition Workforce.

The acquisition workforce has traditionally been trained in how to use the Federal Acquisition Regulation (FAR) and other guides and instructions; but, if members of the acquisition community are now expected to be innovative, they have to be trained in how to do that. One middle management participant related this anecdote from a member of an audience to which he had spoken, "I used to be able to sit down at my desk and open my cookbook and follow the recipe, and I'd get done with the product. You took my recipe book away from me, and I don't know what to do." One avenue to train the acquisition community



is to expand educational efforts in areas such as strategic purchasing, the entrepreneurial mindset, and organizational management and transformation.

Continually Challenge Waiver Processes to Reduce Approval Effort.

A pervasive opinion among respondents was that requesting waivers to existing processes, however broken they might be perceived to be, is too time intensive. Waiver processes should be subject to continual review to ensure they support change and not discourage it. This view is supported by one senior respondent, who said:

“So what's important for me in an initiative is that it be something I can do and it would be value added and it would actually cut my work. In other words, don't tell me... I can have an exception to somethin' if I have to go ask for -- you know, I have to go sell this exception to every layer of bureaucracy I've gotta work with. It just doesn't-- it's-- it's just here, let me do it the regular way.”

Clarify Future Initiatives.

One middle management participant noted that when the term acquisition reform initiative is used “the rest of the Air Force thinks it only applies to the acquisition world.” Future initiatives should not use buzzwords like acquisition or acquisition reform, but instead appeal to the Air Force as a whole. The new Air Force initiative “Smart Ops 21”, which focuses on process improvement across the Air Force, is an encouraging step in this direction. Future initiatives should be very specific, and metrics and a commander's intent statement should be released along with the initiatives. The initial metrics can be adjusted if they prove to be driving undesirable behaviors, but this study suggests starting with some metrics is better than starting with none.

Consistent Statement of Initiative Support from Senior Air Force Leaders.

Lastly, it is recommended that both the Secretary of the Air Force and the Chief of Staff of the Air Force be asked to include periodic statements of support for continued acquisition reform, stressing the importance of compliance with acquisition initiatives in their monthly newsletters (Vectors and Sight Pictures, respectively). Such statements would address the prevailing and pervasive request from interview participants and others for consistent, continual, vocal support for the initiative of interest from the Chief and other senior Air Force leaders. The Chief and the Secretary's continued and open support would enable those expected to implement the initiatives to really challenge the party-line way of doing acquisitions, become innovative, and change the acquisition process.

Future Research

The future research should focus first on validating the findings of the qualitative research. A questionnaire can be constructed using the data gathered from the interviews. The questionnaire can be used to evaluate the generated metrics along the dimensions of “good” metrics; specific metrics that apply to the categories of metrics this research will suggest can then be identified during future research.

Summary

This study gives Air Force leaders clear, implementable metrics that can be used as measures of success for the “Focus on results, not process” initiative, and provides recommendations that can be used to improve this initiative's performance and that of future



corporate Air Force acquisition initiatives. This study also gives Air Force leaders insight into whether or not this initiative and others like it are an appropriate and effective way to drive the changes they are meant to bring about. Finally, from a broader perspective, the framework used in this study can be used to develop measures of success for other corporate level Air Force acquisition initiatives.

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Plenary Panel – Estimating Return on Investment & Valuing Real Options in Acquisition

Thursday, May 18, 2006	Estimating Return on Investment & Valuing Real Options in Acquisition
8:30 a.m. – 10:00 a.m.	<p>Chair:</p> <p>Tom Housel – Naval Postgraduate School</p> <p>Papers:</p> <p><i>Using KVA and Real Options Analysis in Acquisition: Two Case Studies</i></p> <p>Johnathan Mun, Naval Postgraduate School</p> <p>Tom Housel, Naval Postgraduate School</p> <p><i>Estimating Return on Investment and Valuing Real Options in Acquisition: “Market Comparables”</i></p> <p>Glenn Cook, Naval Postgraduate School</p> <p>Capt Scott Uchtyl, USMC, Naval Postgraduate School</p>



Using KVA and Real Options Analysis in Acquisition: Two Case Studies

Presenter: Johnathan Mun, is the founder and CEO of Real Options Valuation, Inc., a consulting, training and software development firm specializing in real options, employee stock options, financial valuation, simulation, forecasting, optimization and risk analysis located in northern California. He is the creator of the *Super Lattice Solver* software, *Risk Simulator* software and *Employee Stock Options Valuation* software at the firm. He has also authored numerous books including *Real Options Analysis: Tools and Techniques*, *Real Options Analysis Course: Business Cases*, *Applied Risk Analysis: Moving Beyond Uncertainty*, and others.

Tom Housel, specializes in valuing intellectual capital and knowledge value measurement. He is currently a tenured Full Professor for the Information Sciences (Systems) Department. He won the prestigious Society for Information Management award for best paper in the field in 1986. His work on measuring the value of intellectual capital has been featured in a Fortune cover story (October 3, 1994) and Investor's Business Daily, numerous books, professional periodicals, and academic journals (most recently in the *Journal of Intellectual Capital* vol. 2 2005).

Abstract

The United States has experienced dramatic changes in national security over the past 15 years, shifting away from the conventional threats posed during the Cold War era to more unconventional threats as evidenced by the tragic events of September 11 and the continuing global war on terrorism. To meet the challenges of the new national security environment, the Department of Defense (DoD) plans to spend \$1.3 trillion between 2005 and 2009 for major programs ranging from new intelligence programs to homeland defense and military operations overseas.¹

With lives at stake and billions of dollars at risk, difficult choices are made by the DoD on which projects to fund where tradeoffs occur. Should investments be made towards personnel or towards new technology? Should more funding be allocated towards intelligence collection or processing? To evaluate and select projects returning maximum benefits, new measurement tools are critical to properly define, capture and measure the total value of investments. These tools must be capable of capturing data across a spectrum of organizations to compare processes, capabilities, costs, revenues and other benefits. In addition, they must incorporate elements of uncertainty and risk that are inherent in predicting the future. Understanding uncertainties and the potential impact of risks can significantly improve the likelihood of successful investment decisions.

This research utilized the Knowledge Value Added/Real Options (KVA+RO) valuation framework to address those issues. KVA+RO is designed to support information technology (IT) portfolio investment decisions. It is intended to empower decision-makers by providing performance-based data and analyses like the ROI on individual projects, programs and

¹ GAO. (November 2005). *Better support of weapon system program managers needed to improve outcomes*. Washington DC, author.



processes within a portfolio of IT investments. Using KVA historical data as a platform, potential strategic investments are evaluated with real-options analysis.

This executive summary introduces the KVA+RO valuation framework. The first section of this report discusses limitations of existing return on investment (ROI) approaches in the DoD. The paper then presents KVA+RO methodology and framework, reviews core concepts, underlying assumptions, metrics and potential applications to the IT portfolio management problem in the DoD. In the final section, the KVA+RO valuation framework is applied to two cases: assessing the potential ROI for using the open-architecture approach in building integrated warfare systems and in assessing the potential ROI and real options in using collaborative and 3-D technologies in design for ship maintenance and modernization processes.



Estimating Return on Investment and Valuing Real Options in Acquisition: “Market Comparables”

Presenter: Glenn Cook, Naval Postgraduate School

Presenter: Capt Scott Uchytel, USMC, Naval Postgraduate School

Problems may arise when leaders in non-profit and governmental organizations, such as the Department of Defense, attempt to discuss the “value” of an asset in use. This is because there are no revenue streams in such organizations. The results are non-productive debates about the relative value produced by assets, especially intellectual capital assets (e.g., knowledge in people or in information technology). This presentation focuses on how the market-comparables approach can be used to establish surrogate revenue estimates for defense process outputs. We will provide a case example of this approach in the application of open-architecture principles to the “track management” function of shipboard combat information centers.

Market comparables is an approach to the valuation of a business entity based upon the performance of comparable entities in the greater marketplace. Valuation methods such as the market-comparables approach are based upon the assumptions that the value of an interest in a business depends upon the future benefits that will accrue to the owner of that business. The best market-comparables approach is to project some category or categories of future benefits of ownership in companies comparable to the company being valued. This approach typically includes some measure of economic income such as cash flow, earnings or dividends among the comparable companies.

When determining the market comparable value of a business entity, the parties involved may rely on historical or projected benefits. Both approaches can be considered valid if the underlying assumptions are known and understood, and all parties related to the valuation are in agreement. Historical revenue and cost data are considered evidence of past performance and tend to be easier to gather and create consensus than projected benefits.

There are typically two approaches to market comparables: one that focuses on the performance of comparable companies and one that focuses on the comparable value of real estate assets. The first approach depends on historical financial performance of comparable companies as well as projections of the future cash-flows of the companies. This market-comparables approach did not make sense in the context of attempting to derive a revenue estimate for governmental processes since there are no comparables in terms of cash-flow-based performance. However, the real estate asset comparables provides a useful path because it is based on the assumption of common units’ comparisons in terms of selling price per square foot of the asset.

The market approach in real estate looks at comparable properties and determines a price basis within a common market, usually for the purpose of securing a loan on the property. For example, most residential real estate is valued based upon the price per square foot of comparable properties that have already been sold. In a given market, the first step in determining a price is to multiply the square footage of the property by the market average price. Then, other factors such as location and amenities will add or deduct value to arrive at an acceptable price. Final valuation of the property is based upon the market and negotiations between buyers and sellers.



In terms of the valuation of assets at the sub-corporate level, several of these approaches can be applied even though they are generally geared towards the valuation of the entire corporate entity. On the one hand, we advocate comparing common units of output among commercial and governmental processes, which is similar in nature to the comparison of price per square foot. On the other hand, we use these common units to establish a price per unit that can be aggregated in the governmental processes to establish a revenue estimate.

To accomplish this, we use the KVA approach to establish common units of output for DoD processes and comparable processes in for-profit companies. The commercial companies' revenue is allocated to their common units of output from all sub-corporate processes. This establishes a range of prices per unit of output among the sampled commercial companies. The average price per unit then can be applied to the outputs of the comparable DoD processes to achieve an aggregated revenue figure (i.e., average price per unit of aggregated output in terms of the number of common units of output). In this way, revenue streams are assigned to the processes. Because the amount of units of output from each process asset is known, the surrogate revenue for each asset can be assigned.

In terms of choosing the approach to valuation, there are several factors to consider. The foremost is related to the choice of the assets to be valued. This choice revolves around the idea of which aspect of the asset means the most to the valuation. Is basing the value upon the physical characteristics of the asset itself or on the core processes a better determination of value? For example, the Puget Sound Naval Shipyard in Bremerton Washington is the Navy's sole site for the overhaul of Nuclear-powered Aircraft Carriers. If one were to make a market comparison based upon the physical nature of the assets, one would need to find and value a commercial shipyard that overhauls large, nuclear-powered vessels. Unfortunately, that would be impossible. There are shipyards that build nuclear ships (Northrup-Grumman) but the comparison between a building yard and a repair yard will likely run into problems of scale and scope.

However, if the market-comparables approach were based upon a comparison of core processes, there would likely be a larger number of ready comparisons. The core processes of a shipyard that repairs large Navy (100,000 ton) vessels that require regular maintenance are comparable to commercial shipyards that repair large cruise ships and oil tankers. Both of these types of vessels can and do approach the size of an Aircraft Carrier; both are productive assets that need maintenance; and both are assets that need to be returned to productive service in a minimal amount of time. Thus, the comparison based upon core processes can create market-comparables valuation that might closely approximate that of the government shipyard.

In this presentation, we will discuss on-going research into a proof-of-concept application of market comparables to analyze the value of undertaking an "open-architecture" (OA) approach to the development of combat systems suites. The Program Executive Office, Integrated Warfare Systems (PEO IWS), OA Division is charged with implementing the Navy's OA plans, policies and initiatives. One of these initiatives is the development of an open-architecture approach to implementing a situational awareness (SA) system for the DD(X) project. To accomplish this, PEO IWS has looked at both the AEGIS and SSDS platforms to determine specific elements of each track management system that could be reengineered using an OA approach for placement into the DD(X) program. In doing this, metrics must be looked at to determine the best modules that might be candidates for open architecture.



This research project gathered information from subject matter experts (SME) from the Surface Fleet and from training commands at Dahlgren (AEGIS) and Wallops Island (SSDS). The process information garnered from these SME's was aggregated to provide a value for each process using the KVA methodology. The resulting Return on Knowledge (ROK) was then analyzed to determine where information technology, specifically with relation to open architecture, could be applied to enhance the operational capabilities of a Naval vessel. Finally, a market-comparables analysis was conducted on ROK values generated from a proposed model of the system. The output of this analysis provides the sponsor with a clearer idea of specific processes within the systems that could be reengineered with an open-architecture (OA) approach to provide the greatest efficiency to the operational fleet. The KVA data also provides the inputs to the analysis of the real options that the OA approach provides for IWS development.



Panel – Alternative Methods for Financing Defense Acquisition

Thursday, May 18, 2006	Alternative Methods for Financing Defense Acquisition
10:15 a.m. – 11:45 a.m.	<p>Chair:</p> <p>Joe San Miguel – Naval Postgraduate School</p> <p>Discussants:</p> <p>Gerald Koenig – Hannon Armstrong</p> <p>Nancy Mattson – Argent Group. Ltd.</p> <p>Papers:</p> <p><i>Acquiring Combat Capability through Innovative Uses of Public Private Partnerships</i></p> <p>Capt Steve Buchanan, USAF, Naval Postgraduate School</p> <p>Capt Daniel McCrary, USAF, Naval Postgraduate School</p> <p>Capt Jayson Cabell, USAF, Naval Postgraduate School</p> <p><i>An International Perspective on the Use of Public Private Partnerships to Augment Military Capabilities</i></p> <p>LCDR Pat Jankowski, USN, Naval Postgraduate School</p> <p>LT Matt Lehmann, USN, Naval Postgraduate School</p> <p>LT Mike McGee, USN, Naval Postgraduate School</p>

Overview:

There is clearly heavy pressure in Washington to limit the DoD acquisition budget. There is also a steady stream of “critically important” new weapons systems under development across all branches of the military. The result will necessarily be that many “highly desirable,” if not “critical,” programs are cut back or even eliminated.

One way to ease this potential impairment of National Security is to fund some DoD investments outside the normal Congressional appropriations process. One term for such alternative financing mechanisms is “Public-Private Partnerships” (PPP).

PPPs have proven to generate substantial benefits for the public sector by providing greater flexibility in financing, encouraging innovation, reducing risks, and saving time and money on projects. Deputy Secretary of Defense, Paul Wolfowitz, made the following statement on the importance of more flexibility and less oversight in the acquisition system to deliver affordable, sustainable capability to the warfighter:



"I have determined that the current DoD Directive 5000.1, "The Defense Acquisition System," DoD Instruction 5000.2, "The Operation of the Defense Acquisition System," and DoD 5000.2-R, "Mandatory Procedures for Major Defense Acquisition Programs (MDAPS) and Major Automated Information Systems (MAIS) Acquisition Programs," require revision to create an acquisition policy that fosters efficiency, flexibility, creativity, and innovation. Therefore, by separate memorandum, I have cancelled those documents immediately."

Deputy Secretary of Defense Paul Wolfowitz, Policy Memorandum, Cancellation of DoD 5000 Defense Acquisition Policy Documents, October 30, 2002.

Acquiring Combat Capability through Innovative Uses of Public Private Partnerships

Presenter: Capt Steve Buchanan, USAF, Naval Postgraduate School

Capt Daniel McCrary, USAF, Naval Postgraduate School

Capt Jayson Cabell, USAF, Naval Postgraduate School

An International Perspective on the Use of Public Private Partnerships to Augment Military Capabilities

Presenter: LCDR Pat Jankowski, USN, Naval Postgraduate School

LT Matt Lehmann, USN, Naval Postgraduate School

LT Mike McGee, USN, Naval Postgraduate School



Panel – Considerations in Making Logistics Support Choices for Weapon Systems

Thursday, May 18, 2006	Considerations in Making Logistics Support Choices for Weapon Systems
10:15 a.m. – 11:45 a.m.	<p>Chair:</p> <p>Reuben Pitts – Major Program Manager Integrated Combat Systems, PEO IWS 1.0</p> <p>Discussant:</p> <p>CAPT Stephen Huber, USN – Commander, Naval Surface Warfare Center, Port Hueneme</p> <p>Papers:</p> <p><i>On Budget Allocation to Increase Operational Availability and Reduce Readiness Risk through Improvements in Weapon Systems Logistics</i></p> <p>Keebom Kang, Naval Postgraduate School</p> <p>Kenneth Doerr, Naval Postgraduate School</p> <p>Uday Apte, Naval Postgraduate School</p> <p>Ira Lewis, Naval Postgraduate School</p> <p><i>Evaluation of Performance Based Logistics</i></p> <p>Kenneth Gabriel, University of Maryland</p> <p>Jacques Gansler, University of Maryland</p> <p>William Lucyshyn, University of Maryland</p>



On Budget Allocation to Increase Operational Availability and Reduce Readiness Risk through Improvements in Weapon Systems Logistics

Presenter: Keebom Kang, Naval Postgraduate School

Kenneth Doerr, Naval Postgraduate School

Uday Apte, Naval Postgraduate School

Ira Lewis, Naval Postgraduate School

Overview

The goal of this research is to develop a decision support framework to inform the acquisition of logistic services for a weapon system. The primary element of this decision support framework is an explicit choice model of the tradeoff between life-cycle cost on the one hand and improvements in Operational Availability (Ao) on the other hand. This tradeoff is encountered when there are a number of opportunities to improve Operational Availability through the acquisition of logistics services for a weapon system with a limited budget, so that all opportunities cannot be pursued. In such a case, several criteria are important, including both average operational availability, as well as the risk that operational availability may fall below some planning threshold (which we call *readiness risk*).

The Department of Defense (DoD) is increasingly interested in contractual agreements and public-private partnerships to improve weapon systems logistics. Such agreements and partnerships are often established under the umbrella of Performance Based Logistics (PBL). Under PBL agreements, performance outcomes are specified, and vendors are given a large degree of autonomy to determine the means of accomplishing those performance outcomes. Often, PBL agreements are established at the component level (e.g., depot-level maintenance of an aircraft engine), and a recent review by the Government Accountability Office² was supportive of component-level agreements for PBL, but critical of system level agreements.

However, the DoD values performance at the systems level because only systems, and not components, help to determine war-fighting outcomes. Recent guidance has been directed toward five key performance criteria: 1) *weapon system* operational availability, 2) *weapon system* operational reliability, 3) *weapon system* cost per usage, 4) logistics footprint for a *weapon system*, and 5) response time required for *weapon system* logistics support.³

² Government Accountability Office (2004). "Opportunities to Enhance the Implementation of Performance Based Logistics," Report the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate. August 2004.

³ Office of the Secretary of Defense, Undersecretary for Acquisition, Technology & Logistics (2004). PBL Purchasing Using Performance Based Criteria. Proceedings of the 2004 DoD Procurement Conference, Orlando, FL.



Evaluation of Performance Based Logistics

Presenter: Kenneth Gabriel, University of Maryland

Jacques Gansler, University of Maryland

William Lucyshyn, University of Maryland

Abstract

Performance-Based Logistics (PBL) is an alternative logistics support solution that transfers inventory management, technical support, and the supply chain function to a provider who guarantees a level of performance at the same or reduced cost. Instead of buying spares, repairs, tools, and data in individual transactions, the method in a performance-based logistics arrangement is to buy a predetermined level of availability that meets the warfighter's objectives.

In most cases, PBL agreements are multi-year (5-15 years, base plus options) and often result in part or all a systems supply chain being managed by a contractor. In the traditional support concept the supplier is incentivized to sell parts. This approach reverses vendor incentives. A "pay for performance" contract now motivates the vendor to reduce failures and consumption. A long term investment also enables the vendor to balance the risk vs. the required investment. As a result, these long term partnerships with industry can leverage commercial best practices, and result in increased system availability, less infrastructure, and reduced costs.

For example, the Navy uses a PBL contract for the F/A-18E and the two-seat F/A-18F. This aircraft perform a variety of missions, including air superiority, day and night strike with precision-guided weapons, fighter escort, and close air support. Through the F/A-18E/F Integrated Readiness Support Team (FIRST) PBL contract, valued at \$750M over five years, Boeing provides aircraft support that includes supply chain support, reliability improvements, obsolescence management, E/F squadron activation, technical publication, and support equipment management. The availability rate of the F/A-18 E/F has been 85%, as compared to a 73% for the F/A-18 C/D which is supported by a traditional logistics system. This report will examine and evaluate the performance of existing PBL initiatives, focusing on issues that include: contracting challenges, government data rights, maintaining a competitive environment, and developing incentives for standardization.



Panel – Perspectives in Program Management

Thursday, May 18, 2006	Perspectives in Program Management
12:45 p.m. – 2:15 p.m.	<p>Chair:</p> <p>Kenneth Miller – Special Assistant for Acquisition Governance and Transparency to the Secretary of the Air Force</p> <p>Papers:</p> <p><i>Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes</i></p> <p>Michael Sullivan, Director, Acquisition and Sourcing Management, GAO</p> <p>Cristina Chaplain, US Government Accountability Office</p> <p><i>When Should You Terminate Your Own Program? Bad Business: The JASORS Debacle</i></p> <p>John Dillard, Naval Postgraduate School</p> <p><i>Managing Tipping Point Dynamics in Single Development Projects</i></p> <p>David Ford, Texas A&M University</p> <p>Tim Taylor, Texas A&M University</p>

Chair: Kenneth Miller, Special Assistant for Acquisition Governance and Transparency to the Secretary of the Air Force.

Mr. Miller, a member of the Senior Executive Service, is Special Assistant for Acquisition Governance and Transparency to the Secretary of the Air Force, Washington, DC. Mr. Miller assists in discharging the responsibilities in the direction, guidance and supervision of Air Force programs for research, development and acquisition of systems, supplies and services. This includes the formulation of acquisition and contracting policies and the management oversight of specific acquisition programs.

Mr. Miller, a native of Columbus, Mississippi, began his professional career in 1975 as an aerospace engineer with the Naval Air Systems Command. He advanced to weapons systems acquisition management as the Assistant Deputy Program Manager for the H-3 antisubmarine helicopter, later serving as Deputy Program Manager for the E-6A and Principal Deputy Program Manager for the A-6/EA-6 Weapons Systems Program Office. In April 1989, the Navy established the new Program Executive Offices within the acquisition system. Mr. Miller was selected to be the first Deputy for Acquisition for the Program Executive Office (Tactical Aircraft), providing policy and execution advice to the Program Executive Officer on assigned programs.



Mr. Miller was appointed to the Senior Executive Service as the second Deputy Program Executive Officer for Tactical Aircraft Programs, providing advice on acquisition-related issues for a variety of aircraft and weapons programs. In 1994, he was selected as the Assistant Commander for Corporate Operations, where his responsibilities included the strategic planning and corporate business functions of the Naval Air Systems Command. Additional duties included Chief Information Officer. In 1998, he was appointed Principal Assistant for Acquisition, Programming and Budgeting for the Director of Air Warfare within the Office of the Chief of Naval Operations. Mr. Miller was later selected as the Assistant Deputy, Chief of Naval Operations, Warfare Requirements and Programs, defining and developing a variety of warfare requirements for the Department of the Navy. He is a frequent speaker at government, industry and national forums.



Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes

Presenter: Michael Sullivan, Director, Acquisition and Sourcing Management, GAO

Presenter: Cristina Sullivan, US Government Accountability Office

Highlights

The Department of Defense (DOD) relies on a relatively small cadre of officials to develop and deliver weapon systems. In view of the importance of DOD's investment in weapon systems, we have undertaken an extensive body of work that examines DOD's acquisition issues from a perspective that draws lessons learned from the best commercial product development efforts to see if they apply to weapon system acquisitions. In response to a request from the Chairman and Ranking Minority Member of the Subcommittee on Readiness and Management Support, Senate Committee on Armed Services, this report assesses (1) how successful commercial companies position their program managers, (2) how DOD positions its program managers, and (3) underlying reasons for the differences.

In compiling this report, GAO conducted a survey of program managers. See <http://www.gao.gov/special.pubs/gao-06-112SP/index.html>.

GAO recommends the Secretary of Defense develop an investment strategy to prioritize needed capabilities; require senior stakeholders to formally commit to business cases for new weapon system developments; and develop a process to instill and sustain accountability for successful program outcomes. DOD agreed with our recommendations.

U.S. weapons are among the best in the world, but the programs to acquire them often take significantly longer and cost more money than promised and often deliver fewer quantities and capabilities than planned. It is not unusual for estimates of time and money to be off by 20 to 50 percent. When costs and schedules increase, quantities are cut, and the value for the warfighter—as well as the value of the investment dollar—is reduced.

When we examined private sector companies that developed complex and technical products similar to DOD, we found that their success hinged on the tone set by leadership and disciplined, knowledge-based processes for product development and execution. More specifically, long before the initiation of a new program, senior company leaders made critical investment decisions about the firm's mix of products so that they could commit to programs they determined best fit within their overall goals.

These decisions considered long-term needs versus wants as well as affordability and sustainability. Once high level investment decisions were made, senior leaders ensured that programs did not begin unless they had a business case that made sure resources were in-hand to execute the program—that is, time, technology, money, and people. Once a business case was established, senior leaders tasked program managers with executing that business case for each new product from initiation to delivery, but required their program managers to use a knowledge-based product development process that demanded appropriate demonstrations of technology, designs, and processes at critical junctures. The program manager was empowered to execute the business case, but also held accountable for



delivering the right product at the right time for the right cost. Requiring the program manager to stay throughout the length of a project was a principal means of enforcing accountability. Overall, by providing the right foundation and support for program managers, the companies we visited were able to consistently deliver quality products within targets, and in turn, transform themselves into highly competitive organizations.

DOD program managers are put in a very different situation. DOD leadership rarely separates long-term wants from needs based on credible, future threats. As a result, DOD starts many more programs than it can afford--creating a competition for funds that pressures program managers to produce optimistic cost estimates and to overpromise capabilities. Moreover, our work has shown that DOD allows programs to begin without establishing a formal business case. And once they begin, requirements and funding change over time. In fact, program managers personally consider requirements and funding instability—which occur throughout the program—to be their biggest obstacles to success. Program managers also believe that they are not sufficiently empowered to execute their programs, and that because much remains outside of their span of control, they cannot be held accountable.

www.gao.gov/cgi-bin/getrpt?GAO-06-110

www.gao.gov/cgi-bin/getrpt?GAO-06-112SP

To view the full product, including the scope and methodology, click on the links above. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.



When Should You Terminate Your Own Program? Bad Business: The JASORS Debacle

Presenter: John Dillard joined the NPS faculty in the fall of 2000 with extensive experience in the field of systems acquisition management. His research focuses on defense acquisition policy changes and their implications. Dillard began his career in program and contract management after attaining a MS in Systems Management from the University of Southern California in 1985. He has been involved with myriad technologies and system concepts that have evolved into fielded products, such as the M-4 Carbine, 120mm Mortar, and M-24 Sniper Weapon. He was the Assistant Project Manager for Development of both the Army Tactical Missile System and, later, the JAVELIN Antitank Weapon System at Redstone Arsenal, Alabama. All of these systems incorporate state-of-the-art technologies, are in sustained production and fielding, and are now battle-proven. He was the Product Manager for the Joint Advanced Special Operations Radio System, and in 1998 was appointed to head Defense Department contract administration in the New York metropolitan area. Dillard has consulted for the governments of Mexico and the Czech Republic on achieving excellence in the public sector. As an adjunct professor for the University of California at Santa Cruz, he teaches courses in project management and leadership to Silicon Valley public- and private-industry professionals.

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Preface

The Project Manager (PM) is typically the advocate for his program. He is the champion for his team of government and industry players, the spokesman to higher headquarters for progress in achieving the various parameters of cost, schedule and performance, and the steward of taxpayer funds—on a constant quest for best value.

He must keep the leadership—and sponsors—honestly informed in a timely manner, especially when things don't go as planned. He must continually assess risk and the resources needed to complete the project effort so that he can marshal the appropriate forces against the challenges that invariably arise during the course of execution.

The ultimate goal of a project being to advance warfighting capability, there is little accolade for lesser achievement. It is then perhaps easy for the manager's zeal for success and personal self-worth to become associated with the project. This can allow optimism to reign—and cloud judgment—by unintentionally filtering and distorting information.

A recent article describes the frustration of Congressional stakeholders with program cost overruns—whether from inaccurate early estimates, requirements creep or just poor management. There are even concerns over deliberate deception. On whether acquisition executives might ever consider terminating programs that spin out of control, their statements



affirm that indeed they have and will move to terminate overrunning programs at control gates or cost “trip wires.”⁴

An implied question arises from this testimony, “When should a PM advocate his own program’s termination?” That is, as ones closest to and perhaps most knowledgeable about their programs, should PMs ever initiate or recommend program termination to their leadership? And if so, under what criteria should this occur, and what should be the methodology?

What follows is a *Personal Experience Monograph* written in 1997 at the US Army War College at Carlisle Barracks, Pennsylvania. It is a reflection upon events during the period 1992 through 1994, seen through the eyes of a PM (this author) who inherited a doomed program, and what actions he took as these events unfolded. It can perhaps serve as a case study for those who might find themselves in similar circumstance.

Several points can be taken from this monograph that might be applied universally:

- Arguably most important is that it is not the PM's decision whether a program can or should be terminated—It is the sponsor's to make.
- Organizational divisions—divided houses of requirers, acquirers, and end-users actually afford checks and balances. So, there is latitude for candor and forthrightness. Above all, PMs are in the position to do what is right, or at least report what they think it to be. Given the ethical dilemma (oft-defined as the choice between two bad outcomes) of termination (with its ugly personal/professional exposure) or almost certain failure, PMs must have the moral courage to elevate the issues to the appropriate level of decision-making.
- From a requirements standpoint, since all programs must compete for scarce resources, it is prudent for systems pursued to be arrayed within a functional area architecture or framework that spans timelines and capabilities. A lucid and coherent commodity strategy should stand the test of time and leader turbulence. The life and death of programs will always hinge upon their validated need.
- From a programmatic standpoint, acquisition rules and policies have evolved toward sensible guidance for the execution of programs. While we seek the removal of bureaucracy and red tape at every opportunity, we must be nonetheless judicious in the application of good management practices and principles. There is no benefit to shortcutting things like rigorous requirements analysis and definition (and documentation thereof), and a thorough analysis of alternatives. Likewise, product lifecycles should be tailored according to technology readiness vis-à-vis timing of need. Rapid results can be obtained without the necessary loss of good sense and discipline. There is no substitute for good staff work.
- All programs must face the periodic and external examination of:
 - Cost and schedule estimates
 - Capability gains over the baseline system being replaced
 - Competitive threats and validated need

⁴ Cahlink, G. (2005, November 3). House lawmakers ask military services to rein in rising weapon cost. *Defense Daily*.



- Management activities, expenditures, etc.

No individual or organization in the DoD environment is above public scrutiny of these and other aspects of our programs.

- It is not up to the PM to defend requirements, or to tell the end-users what they want. Their job is to provide the solution to a clearly articulated need. PMs manage cost, schedule, and technical performance. Users manage what is needed, how it will be employed, and how many will be procured.
- When it is clear that the necessary ingredients of a healthy program (a motivated and talented team, a contractual vehicle, sponsorship, fully defined requirements, and resources for the proposed solution—time/money/technology) do not exist or will not soon arrive, it is incumbent on a PM to recommend termination up the chain.

It is as important for PMs to innovate as it is for them to tell the truth—whether to ascertain ways of reducing scope, creating palatable solutions for leader decisions, or presenting original ideas for re-scoping. From producing a materiel solution to extricating the teammates from a failed endeavor, PMs must think creatively and keep things moving toward a positive end.

Bad Business: The JASORS Debacle⁵

MY CALL TO ACTION

In October of 1992, my name emerged on the FY93 Command and Product Manager (PM) List. I had been selected to leave Redstone Arsenal's JAVELIN anti-tank missile program office and move to Fort Monmouth, NJ, the home of the Army's Communications and Electronics Command (CECOM)—a two-star commodity command under Army Materiel Command (AMC). I was to be the Product Manager for the Joint Advanced Special Operations Radios System (JASORS)—a set of lightweight, super-secure communications equipment for the Special Operations Forces of Army, Navy and Air Force.

I was surprised at the equipment commodity I was going to. I had been an Infantry officer before learning the acquisition business, with most of my experience in the missiles and armaments arena. I had no signal-type expertise: I had often jumped a PRC-77 radio as a company commander in the 82d Airborne Division, but turning it on and off was about all I knew of communications. I had worked in the ATACMS project office, also at Redstone, during a critical development and testing phase, and at Picatinny Arsenal prior to that—developing advanced technology for small arms and mortar systems. I knew there were no missile or armaments jobs open that year, but I, nonetheless, was excited about making a material contribution to the Special Operations folks with whom I had a long kinship during my days with the conventional paratroopers at Fort Bragg. Many of my good friends served with the Special Forces, and, being Ranger-qualified and a master jumper as well, I understood their roles and missions. To even better prepare myself, I enrolled in the Special Operations Staff Officer Course at Hurlburt Field, Florida.

⁵ The first draft of this working paper was published 21 February 1997 by Lieutenant Colonel John T. Dillard, USA and Professor Douglas V. Johnson, Project Advisor for the US Army War College (USAWC) Writings Study as a Personal Experience Monograph. The USAWC is located in Carlisle Barracks, Pennsylvania.



Before moving up to Fort Monmouth, I wanted to learn all I could about JASORS. I found quite a few articles in the military library at Redstone. It was one of GEN Steiner's (then the Commander) high priority US Special Operations Command (USSOCOM) programs. It was big dollars and complex technology for an aggressive set of size and weight requirements. JASORS was fully ten percent of the entire USSOCOM R&D budget for the year.

A FORETELLING OF TROUBLE

While at Hurlburt, I met the incoming USSOCOM Commander, GEN Wayne A. Downing. As we chatted, he said to me, "So you're the new JASORS PM. Well, I'll tell you, right now I don't know if we still need your system, and if we do, I don't know if we can afford it." A bit surprised, I pledged to him my best efforts as PM, and to advise him on those two issues as soon as possible so he could make an informed decision. I promised a revised threat assessment by NSA and a revised cost estimate within the month. We certainly didn't need to be inventing and buying something we didn't need. But I couldn't help thinking: a very expensive train had already left the station...

The significance of his words could not be overstated. When the requirement for a system, any system, goes "soft"—the program is dead. We just don't have the money, and never did, to keep unwanted programs alive. I knew I'd have to jump on this issue as soon as I took over as PM.

MY WORK BEGINS

I arrived at Fort Monmouth in March 1993 and had 30 days "overlap" with my predecessor to bone up on the program in preparation for taking over on 9 April. I started taking electrical engineering classes and got detailed technical briefings from program personnel. I read all I could get my hands on and had several lengthy discussions with the outgoing PM. I mentioned to him my encounter with GEN Downing. We also received a classified official electronic message from him questioning the need for JASORS in late March. The outgoing PM said he felt it was all "a bunch of smoke" and that I shouldn't fret—the program was alive and well. A few days later, I assumed the PM charter and control of a program office of about nine dedicated government people, and about 100 at contractor facilities. JASORS was my baby now. I was fairly familiar with what this fast-moving train was all about. And I knew I had an immediate crisis on my hands.

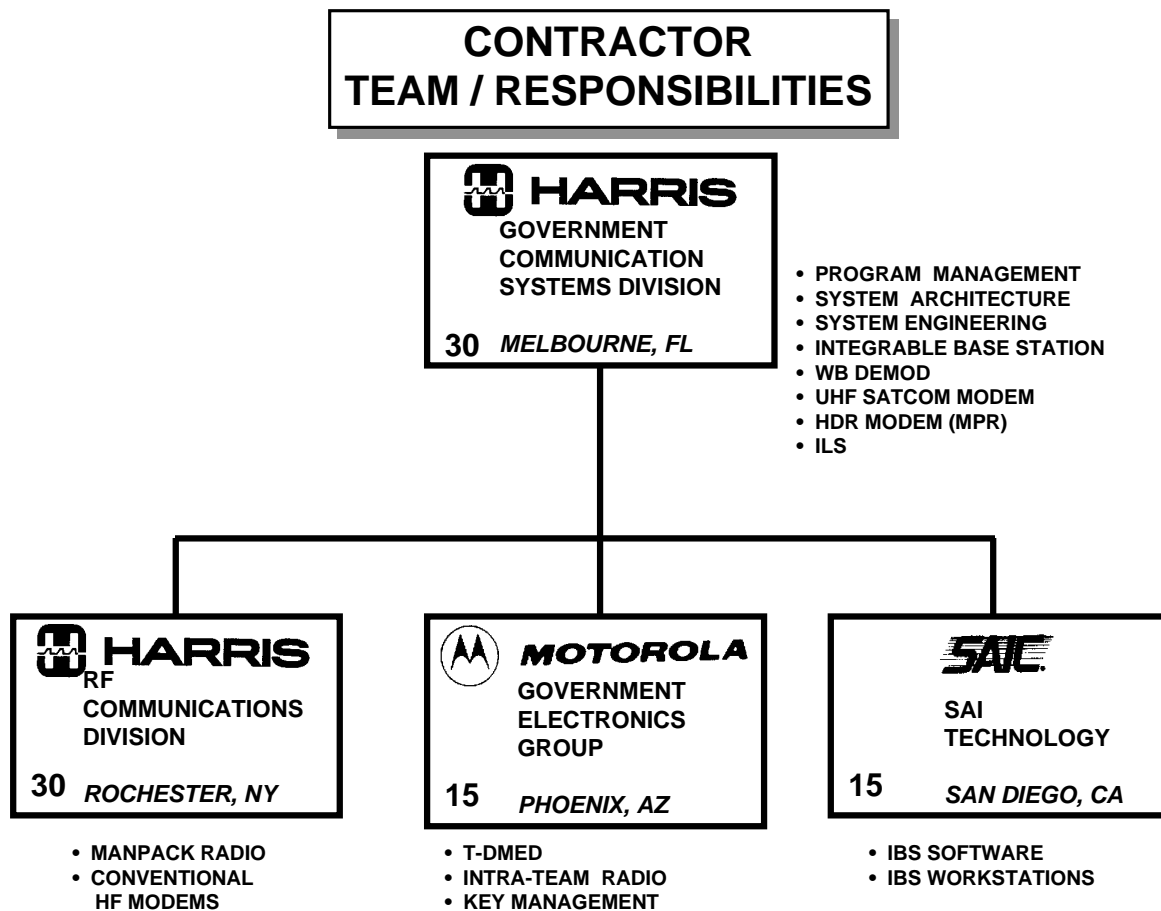
ABOUT THE JASORS PROGRAM

The JASORS program was already three years along in development, and had several unique aspects to it:

- a) The program was on a Cost Plus Award Fee Contract, fairly typical for an R&D program, but had combined the period of performance to cover the first two acquisition cycle phases (then of Concept Exploration & Definition and Demonstration/Validation). The prime contractor was Harris Government Systems Division of Melbourne, Florida. They had major subsystem contracts to Motorola in Scottsdale, AZ, SAIC in San Diego, and another subsidiary of Harris in Rochester, NY. We were very spread out across the US. The chart below illustrates the contractor team relationships. Numbers represent people (staffing).



Figure 1. Contractor Team Relationships



- b) The cycle phases were actually misnamed: “CE&D” was really Dem/Val (building prototypes) and “Dem/Val” was really Engineering Manufacturing Development (EMD) (final design & testing for production). The traditional “CE&D Phase” was really skipped. That’s the phase where important system-concept studies are usually conducted, and requirements are formalized. The JASORS program was already “bending metal” and building prototypes.
- c) The CECOM/SOCOM relationship: I worked for the CECOM Commander, then MG Otto Guenther, though my product was for USSOCOM—a fairly new Command, born after the Goldwater-Nichols Act of 1986, which was still struggling with the complexities of systems acquisition and the critically important roles of the “User” (Combat Developer) and Materiel Developer. Authority for both resided in the same four-star house—unlike the Army’s separate Training and Doctrine Command (TRADOC) and Army Materiel Command (AMC).
- d) My money was from Major Force Program 11, an appropriation of funds for USSOCOM only—no one else could decrement me or even transfer my money elsewhere.
- e) To date, \$44 million had been spent, and no Cost Operational Effectiveness Analysis (COEA), Acquisition Baseline, or Operational Requirements Document (ORD) had been written on the program—which I regarded as not just a serious infraction of the

DoD acquisition regulations, but a strong indicator that this was a program being conducted “on the fly.” System specifications had been written by NSA and CECOM from the USSOCOM Mission Need Statement (MNS), and the PM & contractor had been told to get underway quickly.

- f) As a USSOCOM program, I enjoyed total autonomy as PM. Few people at CECOM (except the folks employed on the program) were very concerned about JASORS because of the separate nature of its funding, and my direct supervisor was the Senior Executive Service director of the entire CECOM R&D Center, rather than a typical colonel in a regular program office.

There were also some unique challenges associated with this endeavor:

- a) The counter-part industry PM had been replaced recently. I would have a new one to work with—he needed to rapidly get aboard a moving train. (And he did. Later I would realize how good a manager, and how professional, frank, and ethical he proved to be.)
- b) The schedule was very ambitious. It began as a two-year effort, but unforeseen work had slipped it an additional year. Now rebaselined, I would carry the baton to the next phase in just six months, beginning a new two-year effort (Dem/Val) to field test and produce the equipment.
- c) Technical performance was largely undemonstrated as of yet, since the sub-system prototypes were only now being delivered to the prime contractor for integration. Twelve “Staged Integration Tests” were soon to begin, and would prove whether anything of merit had been built in the last three years.
- d) In essence, JASORS was to replace everything carried by the SOF A-team in the way of communications gear, with a substantial savings in rucksack weight—our system total was to be only 16 pounds vice 60-100 pounds of baseline capability. But there were some other items also in development or being procured that overlapped with JASORS capabilities.

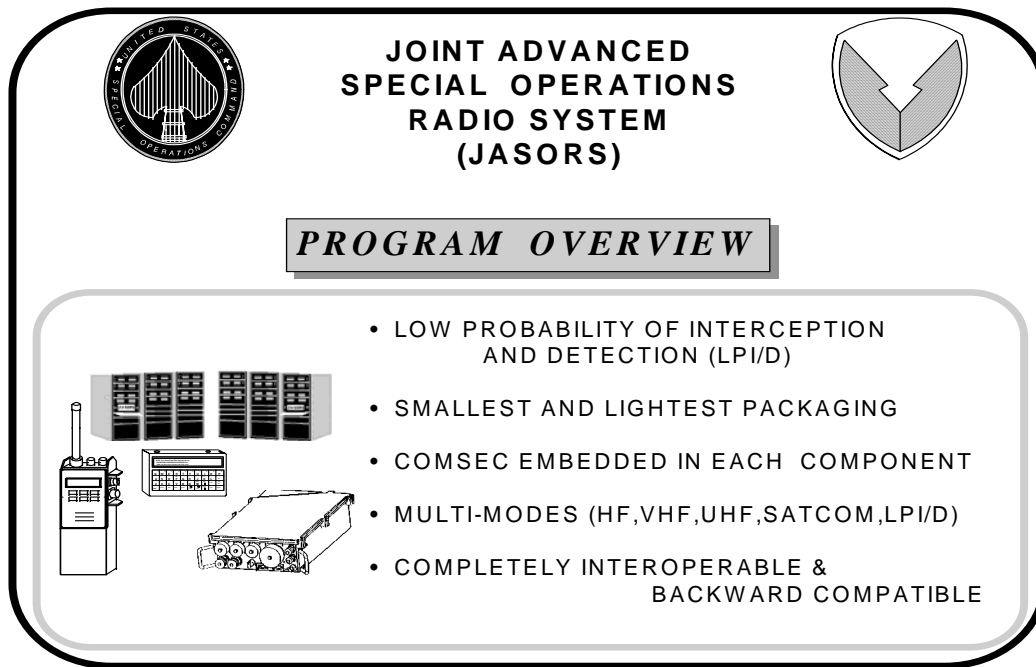


Figure 2. Current SOF Team Commo Gear

REQUIREMENT	CURRENT SYSTEM:	WEIGHT:	OTHER ITEMS PLANNED OR IN DEVELOPMENT:
HF MANPACK	AN/PRC-104A&B	14lbs	ISHMRS 12lbs
TACSAT	AN/PSC-3/LST-5C MST-20	7.7lbs 9.7lbs	EMUT 17.5lbs
VHF/FM INTER-TEAM	AN/PRC-119	19.7lbs	AN/PRC-117D(C) 17.8lbs
SURVIVAL	AN/PRC-112A	3lbs	
AIR TO GROUND	AN/PRC-90&113	3lbs	
SOICS	0A-8990/KL-43	8.8lbs	
SPECIAL RECON LPI/D	NONE		AN/PRC-137 5.3lbs
56 -60 lbs -- PLUS COMSEC GEAR!			
HF BASE STATION	AN/TSC-99/26A	(PRIME MOVER: 2 - 5 ton + 4 - 2 1/2 ton Trucks)	

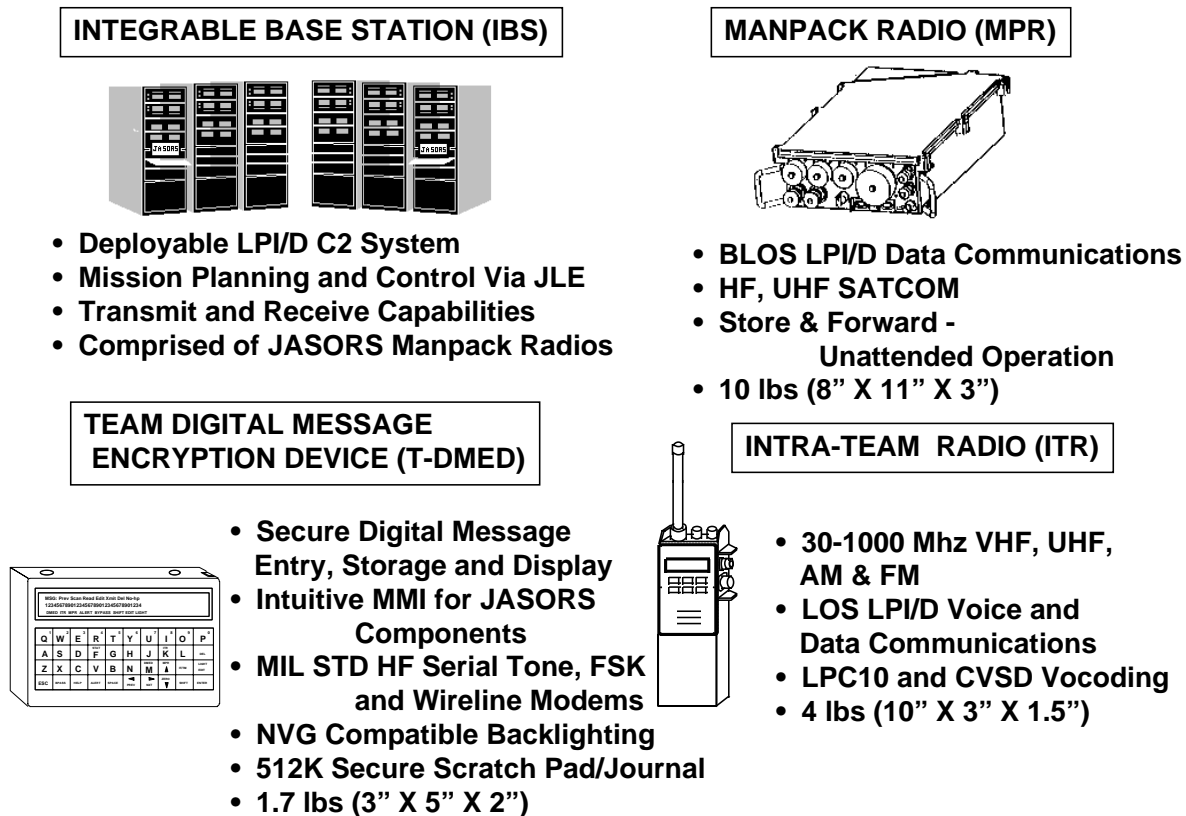
- e) We were also seeking to produce several beyond-the-state-of-the-art waveforms to prevent the detection and interception of SOF radio transmissions (Low Probability of Interception/Detection (LPI/D)), especially during strategic reconnaissance missions. This requirement had sprung from the Warsaw Pact Threat days. USSOCOM wanted a radio that could only be heard by friendly forces. It was the principal and over-arching requirement of the system. The rest was just added on. A previous staff of energetic USSOCOM and USASOC action officers had outlined capabilities for JASORS to replace every SOF radio in their inventory along with a new, more deployable SOF Base Station (movable by one HMMWV versus six 2 ½- and 5-ton trucks). Thus, we also were seeking every possible facet of backward compatibility and interoperability with conventional radios, covering the entire HF, VHF, UHF, AM/FM and SATCOM spectrum, and in a package that was one-man portable: an incredible enterprise—Multi-band, Multi-mode communications in a small, sixteen pound suite of gear. The figure below minimally portrays the system.

Figure 3. JASORS Requirements



- f) System Integration of the subsystems, hardware and software, was a major challenge. We dealt with over 300,000 lines of software code. Interfaces between the pieces were critical.
- g) Embedded (NSA Certified) COMSEC was also a requirement in each piece. That agency's process for certification is as secretive and obscure as their cryptic products.
- h) Power Management (Battery Life) was a tough area where we wanted more than anyone had ever wrung out of a BA-5590 SINCGARS battery. This chart shows a little more depth of system functionality required by the MNS, as well as size/weight of each of the components.

Figure 4. System Components



- i) Cost was a horrific story: The program had been rebaselined twice (a seeming contract buy-in situation), and had grown from \$17M to \$44M for the three-year effort. With the government costs added in, we were to have spent \$62M total by the end of the fiscal year (1993).

A HINT AT THE ROOT CAUSE OF CATASTROPHE

If that all doesn't sound complex or challenging enough, factor in that just as I was taking over as PM, the past cost performance had finally exhausted the patience of the sponsor headquarters (USSOCOM). As well, the next acquisition cycle (Milestone I) decision had been deferred by USSOCOM because of uncertainty of their "new requirements," meaning documents like the ORD weren't ready. Their uncertainty was that, since the Berlin Wall had fallen and the Soviet Union collapsed—and the Persian Gulf War was won—was there any need to fear enemy signals/communications intelligence? The end of the current phase was scheduled for November.

The contractor needed a Dem/Val statement of work from the government PM as soon as possible to propose his estimate and for a smooth transition to next phase of the contract (but that was of course dependent on the ORD). I was informed the User (USSOCOM) was now drafting a new Mission Need Statement—different from the set of requirements the contractor had been working on—and wanted me to review it. It would have significant technical impact, if adopted. (Being a bit unnerved about all the supposed changes, I took a calm approach about being willing to do things differently—and probably over again: like a

building contractor might receive news that the split-level home he's building is really supposed to be a ranch.)

Congressional impatience with USSOCOM's lack of an integrated overarching C4I (Command, Control, Communications, Computers and Intelligence) strategy had triggered a House Appropriations Committee Surveys and Investigations (S&I) Team. They were coming to interview me in four weeks. They were concerned about approximately \$108 million spent in various places on SOF communications-electronics programs in recent years, including JASORS, with nothing produced for the troops in the field.

My program analyst greeted me at the change-of-PM ceremony to inform me that cost variance was again growing, and I would be out of money by July at the current spend rate. The most over-spent subcontractor PM had just returned from his Maui vacation, and had me about eight weeks behind schedule with a poor recovery plan. Lastly, the marketing resources for JASORS had been few, and as a result, the field didn't know the program's status.

On the plus side, the FY94 Budget Estimate Submittal (BES) still reflected \$30M for the program's next phase, but I knew it would have to survive all the House and Senate Authorizations and Appropriations committee marks throughout the summer.

A CHANCE TO MAKE THINGS RIGHT

Over the next several months, I did all I could to learn my program, meet the government and industry players, and separate the "macro from micro" issues. I examined the cost history to understand what happened and why, and I also confirmed that the new rebaseline of cost and schedule was accurate. I visited the troops of 3rd Special Forces Group at Fort Bragg, traveled to all the subcontractors, met with USSOCOM and rendered my total program assessment to their Acquisition Executive (AE) by my 28th day in the job. I wanted to address all of SOCOM's concerns and show a willingness to do anything we could to produce something for them.

I arranged for an NSA threat briefing to the GEN Downing. (The briefing asserted that American forces were still vulnerable to various enemy capabilities for interception of our communications—but was met without a concerned response from the general, who suggested that an enemy capability didn't necessarily establish its probability of use. After all, Saddam Hussein had not jammed our satellites in the Gulf War.)

We had a contract, funding, and a technical team in place. Those things take sometimes years to get. I knew we had the resources to give something to SOCOM if only they could tell us what they wanted. But a senior officer down the hall from my office had worked some other SOF commo projects at CECOM. He cautioned, "They're like drunks in a liquor store, John—they want to buy every shiny bottle." I understood later what he was trying to tell me. This full-Colonel had spent the rest of that \$108 million, with much of what it produced warehoused in Tobyhanna depot. It seems the User had changed his mind fairly often about requirements.

MAKING REAL PROGRESS

I turned my attention to the Staged Integration tests, which were this phase's Grande Finale.



My best technical experts would spend the summer with Harris Corp. trying to put all the prototypes together and demonstrate system functionality—and the world's first truly Low Probability of Intercept/Detection transmissions via an over-the-air encrypted link from upper New York state to Florida.

I asked SOCOM to reinstate Milestone I to the November schedule—we needed that forum for decision-making—and I registered my concern in writing over the lack of user pronency, ORD, etc. I took my boss's boss, MG Guenther, to Florida for a program review with all key players. We pushed SOCOM's Acquisition Executive for commitment and guidance. The Dem/Val statement of work needed to be written and given to the prime for his proposal ASAP, but I delayed spending the money on that effort (about \$1million) in case the new draft MNS was going to dictate changes. I felt it could wait a little longer. We did review the new MNS to assess requirement changes and keep open dialogue, but I also thought it best to hold off incorporation of contract changes until the new requirements were formalized, staffed, & approved. My hunch was later proved to be right—they never were.

I cautioned the prime contractor in writing about his spending rates and published a spend plan that would have him live within our budget through the rest of the fiscal year. I was pleased to find that Harris GCSD in their cost accounting had transcended from simply incurring to actually anticipating costs—an important step few contractors can achieve. When I felt the time was appropriate, I asked for the removal of one of the subcontractor PMs. He had simply not been able to manage the effort successfully, thereby holding up the entire program—and worst of all—I didn't observe that he even cared. He was removed immediately.

Gauging the political winds, I felt the best marketing approach for JASORS was to stay somewhat low-level for a while; though we did take the opportunity to answer press inquiries and take credit for emerging accomplishments.

UP AGAINST A VERY THICK WALL

By the time November rolled around, USSOCOM still had no ORD for Milestone 1. There wasn't even a doctrinal Concept of Operations (CONOPS) for the system. The requirements we had been building prototypes for were never formalized or revised, despite my attempts to bring USSOCOM to the table to create these with all of our assistance. It would be difficult to develop much further with no input from the sponsor. We needed User-specifics for on-screen menus and key management. In the larger picture, USSOCOM did not comply with Congressional language requiring they provide a comprehensive C4I Strategy either. I was amazed at this, and we were definitely programmatically adrift.

The Staged Integration tests had ended successfully—system functionally had been fully demonstrated with long-haul, over-the-air, encrypted LPI/D transmissions from New York to Florida, using only milli-watts of power—without fanfare. We had recovered our schedule to within two weeks of the planned contract completion date by carefully scrubbing our scope and deleting non-value-added deliverables, plans and reports mostly, from the contract. NSA approved of our progress. A summary of what we built and demonstrated is described in most abbreviated fashion below.



Figure 5. CE&D Achievements

- **A-Spec, System Segment Specification, JSID written and allocated**
- **CE&D-Configuration System Design Completed**
- **Prototype Hardware Built (2 DMEDs, 6 MPRs, Base Station)**
- **CE&D Software Written, Integrated & Tested**
- **JASORS INFOSEC Chip (JIC) FAB, I&T, NSA Certification**
- **Favorable LPI/D Vulnerability Analyses & Mode Tests**
- **System and Sub-System functionality Testing Completed**

**OVER-THE-AIR ENCRYPTED, LPI/D, LONG-HAUL LINKS
DEMONSTRATED END-TO END
** A VERSATILE, CAPABLE, TRUE-LPI/D SYSTEM ****

Throughout the summer, I had visited the USSOCOM J-6 offices to apprise them of our status and to help work out the requirement issues. I felt I had their personal trust, but it was clear the action officers and J-6 felt they no longer needed the JASORS they had set out to build just three years earlier. I energized CECOM to form a “Red Team” to see what the cheapest, fastest alternatives would be to the current program, and what technology could be “harvested” from the \$62M we had spent. I offered to completely revamp JASORS into anything SOCOM wanted. But to my frustration, their headquarters would not support any down-scoping or restructuring of JASORS. Nor were any prototypes wanted for delivery (though USASOC, the Army’s Special Operations component, disagreed—supporting further development of the small Digital Message Entry Devices). At least I had not wasted another \$1 million on having Harris propose to our Dem/Val statement of work.

The USSOCOM J-6 was particularly fond of a small radio developed as a classified program. It evolved to be the PRC-137, which offered HF-only, very slow data-rate transmission in an LPI/D mode and non-NSA-certified COMSEC. It didn’t have all the multitude of requirements in size, weight, functionality and interoperability required of JASORS in our MNS and system specs. He felt this was all the radio that USSOCOM needed to procure at the time.

It had been fifteen months of contract performance for Harris since their last award fee evaluation. I couldn’t have been more proud of the performance of everyone on the industry contractor team. SAIC had finally delivered their all-important Base Station Digital Message Entry Devices; Motorola had produced two nearly-fieldable prototypes of miniature Digital Message Entry Devices (DMED) along with the very first simultaneous COMSEC/TRANSEC functioning information security chip that was soon to become NSA certified (and still being procured today); Harris GCSD had tied it all together with a successful integration effort of HF/UHF manpack radios into a base station. Cost was a flat line on my charts for eighteen months—they had stayed within budget and a neatly recovered schedule under their new industry PM. The award fee board agreed. It was with pleasure that we rewarded their efforts with an appropriate fee out of my management budget.



“JULIE-GATE”

The program was still under FY93 funding; there was no FY94 budget yet. Congressional Authorizations and Appropriations committees had picked up on the softening of the USSOCOM JASORS requirement through quiet conversations on the Hill with the USSOCOM Commander and his staff. One day we had the opportunity to place loaded questions in the mouth of the Senate staffer, who the Commander was summoned to the Hill to visit, via my contractor marketing reps—who are free to visit their representatives anytime they wish. Defense contractors, after all, are powerful constituents and often have communicative links with the legislation writers. Pointed questions to the Commander about what direction USSOCOM communications procurement was taking might reveal a weakness in their strategy. But I would have no part in it, and asked my contractors to back off of this tactic to keep their program funded. They agreed and complied. If JASORS were to live, it would be because we were building what USSOCOM at least thought they wanted. As it was, the USSOCOM clandestine plan for JASORS’s “assassination” appeared to be simply having Congress “un-fund” it, rather than providing any direction from USSOCOM headquarters. As expected, the program was used as a billpayer for other wants. When the FY94 budget was finally approved in December 1993, only \$7M was appropriated to JASORS vice \$30m originally requested by USSOCOM—and insufficient to execute anything.

I had enough funds to retain the government staff on the program for a while, but I was prepared to call for immediate termination of the program and cancellation of the contract if I could just get guidance from USSOCOM. Understandably, people at the contractor facilities began to leave the program anyway. This came as a surprise to some folks at USSOCOM, but not to me. People have a natural tendency toward being productive, and Harris had plenty of other work from serious customers who knew what they wanted. I was forced to give Harris a “stop-work” order.

USSOCOM points of contact told me to “wait-out.” A new C4I strategy was forthcoming that would possibly spell out the new direction for JASORS.

WANT A NEW JOB?

It was about this time that I received a strange telephone call from a Major in USSOCOM’s SORDAC (Special Operations Research Development and Acquisition Center). He asked if, given JASORS’s situation, I would like to be the new PM for an exciting new program for the Improved Special Operations HF Manpack Radio System (ISHMRS), a manportable 12-pound straight-conventional HF radio with Automated Link Establishment (ALE). He said my decision would be effective immediately. Just take over the program tomorrow.

I thought for a moment about how ridiculous this call was. It was certainly not for me to decide to drop mine and “adopt” a new program. One which, by the way, also had no ORD, but had lots of money and was “on a fast track to build prototypes.” Legitimate PMs are formally and centrally selected and chartered by the services. Meanwhile, we were two-thirds complete with something a lot more capable, I felt. And we had spent \$62 million on it, and it wasn’t quite dead yet. I pleasantly declined the offer.



SEPARATING PERSONAL FROM PROFESSIONAL

I had a tough time throughout the past year separating personal feelings from the program. I knew better than to identify with the JASORS or attach my ego to it. I had seen systems get canceled before, and it didn't necessarily spell professional death. After all, the PM for Sergeant York later became a two-star general, though I had no such ambitions. (Then) BG Gust, the Program Executive Officer for Communications, had also given me wise and comforting counsel—he had been in a similar position with his program as a lieutenant colonel—the Aquila UAV. The important thing was to do what was right. Mostly, I wanted to do right by the soldiers, like those I met of the 3rd SF Group, who were still humping around old technology in the form of large and heavy backpack radios that had single functions only. They augmented their spares with items they bought from Radio Shack.

ENOUGH IS ENOUGH

It was a short meeting in Washington, DC that started things rolling to culmination: On 4 February 1994, the USSOCOM J-6 action officer privately confided to me that the new USSOCOM C4I Strategy was still not complete—one year after Congress demanded it in law—and that there was, in emerging drafts of the strategy, no requirement for JASORS or any of its subsystems. The officer went on to suggest that the JASORS Product Management Office use the \$7M to maintain a low-level of staffing and to keep the contract alive as “insurance,” in case it was needed later. And maybe to wait for a Command change at USSOCOM. As I gazed out the window of a Crystal City Hotel, I decided enough was enough.

“CONTRACT COMPLETION” VERSUS PROGRAM TERMINATION

Up to that point, we used high-level reviews at USSOCOM and message traffic between general officers to try to alert USSOCOM that valuable resources were dissipating to provide anything to the troops—all to no avail. I rarely got answers to correspondence—even to General Officer message traffic. And I could resolve nothing at the action officer and J-staff level. There seemed to be this tremendous layer of non-communication between Commander-level and his primary staff. No one wanted to approach the upper level for a decision. It was time to terminate my own program.

I was tired of indecision and wasting of the taxpayers' money, and even more tired of wasting the efforts of my own troops: my full-timers in government and almost 100 on my industry payroll. My boss had cautioned me against trying to unilaterally terminate the program, no matter how frustrating it seemed. He was right. He directed that it be a joint recommendation and a USSOCOM decision. On 14 February 1994, I sent the USSOCOM Acquisition Executive a “Valentine” recommending his agreement to terminate the program and harvest the JASORS INFOSEC chip and whatever technology advancements we could document (the technical data package to date). I emphasized it was our only recourse given no requirement and insufficient funding.

The following day I was asked to fly down to USSOCOM and brief the AE and J-6 one more time. We were into face-saving now. While they did want JASORS to die, no one wanted to be the one to kill it. I came up with an idea. I made it palatable to them by declaring it “contract completion” versus “termination.” USASOC wanted the prototype DMEDs and got them, but they weren't suited for much except another iteration of further development to ruggedize them.



All agreed it was finally over, and we could accomplish a close-out of the program without embarrassment to USSOCOM. I walked out of USSOCOM headquarters for what I knew would be the last time as PM JASORS, and I had a tremendous feeling of relief. Placed in charge of a program no longer wanted was emotionally straining. We're known in this life by our works, and when you're working on something no one wants, and you can't disentangle—it's difficult. When *Defense News* later interviewed GEN Downing and asked about JASORS, he simply replied that USSOCOM had to cut many programs due to budget pressures.

I made my way back home to commence termination procedures. It wasn't going to be as simple as just turning out the lights. There were now \$62 million worth of contractual documents and hardware to properly dispose of, and people to reassign. In short, I took delivery of all development documents and had them carefully archived at CECOM. Hardware prototypes that CECOM could use in further waveform research were placed in the Space and Terrestrial Communications laboratory. My people were all reassigned throughout the CECOM. It took only fifty-five days total. I served as a Special Project Officer for the CECOM Commander for a short while, and moved on.

NOW THAT IT'S OVER, WHAT HAVE WE WROUGHT?

My time with JASORS progressed at about the same pace as a soap opera. During the story's unfolding, I carefully and continually analyzed what was going on and why. There is little need to look back and examine further. The catharsis of finally putting it all down on paper here helps—and still frustrates.

We successfully demonstrated multi-band, multi-mode communications, to include the lowest probability of interception/detection modes ever designed, in smaller, lighter packaging than even now exists commercially. We held program cost and schedule to amounts budgeted, and conducted a smooth contract closure in record time. I personally experienced "life as an autonomous PM," and it was a great education with great interpersonal relationships. Those were the good things.

But from my vantage point, we—corporately—failed the soldiers, sailors and airmen of the Special Operations Forces. We wasted 62 million dollars not because we couldn't build JASORS; not because there was something better, cheaper, or faster out there; not because it cost too much; not because we didn't need it. We failed because we didn't have a mission area *strategy*.

What every educated acquisition officer knows is that a program must fit into a larger architecture—whether it's airplanes, missiles, or communications-electronics. Roles and missions have to be delineated. A certain amount of redundancy may be needed, but for the most part, each system must technically perform within a doctrinal concept of operations. And it must stand the test of cost-effectiveness through a proper analysis. Every system competes for funds in the budgetary process. Without a strategy, we're doomed to successive false starts going for the next "shiny bottle." The aggregate of these half-finished programs cost much more than one program properly defined and adhered to. Maybe the authority to both require and procure shouldn't reside in just one headquarters. Maybe checks and balances from independent agencies' eyes are good. Through all the time and effort, USSOCOM had never constructed a simple chart such as this to convey a direction and timeline for the communications gear migration they had once desired.



Figure 6. SOF C-E Strategy

REQUIREMENT:	92	93	94	95	96	97	98	99	00
HF BASE STATION	AN/TSC-99/26A GSC-62					SFBS W/		JASORS INTEGRATED	
	AN/PRC-104A	AN/PRC-104B					JASORS		
HF MANPACK							ISHMRS		
		AN/PRC-137					JASORS		
LPI/D COMM	AN/PSC-3/LST-5C	MST-20					JASORS		
		EMUT							
TACSAT		AN/PRC-117D(C)							
	AN/PRC-119						JASORS		
VHF/FM INTER-TEAM	AN/PRC-90	AN/PRC-112A					JASORS		
SURVIVAL		AN/PRC-113					JASORS		
AIR TO GROUND	0A-8990/KL-43						JASORS		
SOICS									

“WE NEED A STRATEGY... AND MORE DISCIPLINE”

Spending millions of dollars should not be an amateur sport. It all starts with requirements. “Hooah” only takes you so far in the business world of procuring systems. “This looks good” doesn’t cut it. “Let’s buy this” is too cavalier. Good staff work requires thinkers who will tackle the mundane, unexciting tasks of requirements formulation and concepts analysis. What Congressional staffers were asking for, a comprehensive C4I Strategy, is exactly what we didn’t have and needed most—before embarking on the journey. A fundamental question for USSOCOM was: *multi-band communications capabilities or multi-box communications?* (By ending JASORS they elected multi-boxes—de facto.)

USSOCOM had gone “Ready, Fire, Aim.” Another false start to add to their list of ill-fated acquisition excursions. Sadly, USSOCOM is still pursuing the same technical capabilities via new efforts with new players. It’s now [at the time of this writing], 1997—and no JASORS, no ISHMRS, no *anything* new in the soldiers’ rucksacks. They carry the same LST-5 SATCOM radio, same KY-57 COMSEC device, same PRC-104 HF radio, same PRC-119 VHF-FM radio, same 0A-8990 DMED—Low-tech & heavy on their backs.

In 1995, I invited a friend from USASOC to visit the Naval Postgraduate School and talk to my acquisition students. He said a SOF Process Action Team had been formed recently to look inward and examine inefficiencies. When finished, they reported that the headquarters had not been successful in acquisition ventures because they lacked: “guidance from the Commander about his vision or strategy, analysis, integration of the staff’s efforts, and discipline.” I could vouch for that.

A short time later, the world waited to hear whether Air Force Lieutenant Scott O'Grady had survived the shoot-down of his F-16 over Serbian-held territory in Bosnia. But even minimal use of his survival radio might have caused him to be located by his enemy, so he waited for days until he could risk transmitting by voice, and was miraculously rescued. The need for JASORS technology still lives.

EPILOGUE

At the US Army War College, a classmate I had never met and who had been a USASOC action officer during the time I managed JASORS walked up to me at a party and said, "No human could have kept the JASORS program alive. Everyone knows you did all you could."

I was promoted to the rank of Colonel in 1997, and centrally selected for another command: the Defense Contract Management Command in Long Island, New York. While waiting to take command, I was again offered a job as a PM for USSOCOM, at the O-6 level – I politely declined and took command of the DCMC organization instead. It was consoling that I had not alienated the people at USSOCOM—all you really have in this world is your reputation. And it was another note of closure on the death of my old friend. We have to do our best in the circumstances we inherit—and play with the cards we are dealt.



Managing Tipping Point Dynamics in Single Development Projects

Presenter: David N. Ford, PhD, PE, is an Assistant Professor in the Construction Engineering and Management Program in the Zachry Department of Civil Engineering, Texas A&M University. In addition to teaching, he researches development project strategy, process and policy design, and flexibility in projects. Prior this work, Dr. Ford was on faculty in the Department of Information Science at the University of Bergen, Norway, where he researched and taught in the System Dynamics Program. Dr. Ford earned his PhD degree from the Massachusetts Institute of Technology and his Master's and Bachelor degrees in Civil Engineering from Tulane University. He has over 14 years of industry and government experience in engineering and project management.

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Abstract

Previous system dynamics work models the tipping of a series of product development projects into fire-fighting mode in which rework overwhelms progress. Similar dynamics also threaten the performance of individual development projects. The current work extends previous tipping point dynamics research to single projects and demonstrates how a simple, common feed-back structure can cause complex tipping point dynamics, trap projects in deteriorating modes of behavior, and cause projects to fail. Basic tipping point dynamics in single projects are described, analyzed, and demonstrated with the model. Previous researchers have recommended dynamic resource allocation policies to improve project performance threatened by tipping point dynamics. Several strategies for managing projects near tipping points were tested. Policies that were successful in preventing tipping point-based project failure include forecasting demand-based resource policies, policies that provided flexible resource adjustments, and policies that adjusted project deadlines based upon project performance.

Keywords: resource allocation, nuclear plant construction, project management, tipping point, robustness, system dynamics

Introduction

Although development projects are pursued to add value for their developers or users, many projects fail (Evans, 2005; Matta & Ashkenas, 2003; Wells, 1999). Project failure can take many forms, including schedule and cost overruns and unacceptable quality. Project failure is relatively easy to identify if the final product grossly fails to meet performance targets (e.g.,



some of NASA's Mars probes) or if development stops before a product is completed (e.g., the US Department of Energy's Supercollider project). But some projects that are completed should also be considered failures. An example is the Channel Tunnel (the "Chunnel") that connects England and France. While the Chunnel is arguably one of the great engineering achievements of the last century, its final cost of \$17.5 billion was more than double the original estimate of \$7.2 billion (Kharbanda & Pinto, 1996). Chunnel usage is below the level estimated in the project's feasibility study, and even the most optimistic estimates predict that the Chunnel will not be profitable in the next 10 to 20 years (Kharbanda & Pinto, 1996). Although a technical marvel, the Chunnel failed to meet two of its fundamental goals: finish with budgeted funds and produce a financially viable product. Failure of these large projects can have dire consequences for all parties associated with the project.

Project management research has identified many factors that can lead to project failure including overestimation of benefits (Evans, 2005), poor stakeholder analysis (Paul, 2005), and errors (Busby & Hughes, 2004). Despite considerable research into these factors, clearly identifying project failure is difficult. Comparing differences between project performance and targets is a standard means of measuring project success or failure. But variations of final project performance from targets can be poor measures if targets are flexible. For example, US Department of Energy projects are not allowed to exceed Congressionally approved budget targets. So, targets are revised based on final performance, even in cases of gross cost overruns. If performance relative to original targets is a measure of project success or failure, some Department of Energy projects that meet final targets should be considered failures (USGAO, 1996, 1997). Some organizations explicitly label such projects as failures. For example, as part of development improvement efforts, one organization known to the authors labeled a set of completed projects that exceeded their cost or schedule targets by 20% or more as "wrecks" (as in "train wrecks"). A clear, inclusive definition of project failure is needed to study the performance of projects. Changes over time in the work remaining to be completed can provide an improved metric. Although these project backlogs are intended to generally decrease over time, they can stagnate or grow. Projects with backlogs that increase continuously over significant periods of time ultimately lead to failures to meet original project targets and may be terminated. The current work defines a project as a failure when its backlog grows continuously over an extended period of time.¹

The continuous growth of project backlogs over time can be attributed to many different dynamic factors. Dynamic causes identified through system dynamics include a lack of knowledge transfer between projects (Cooper et al., 2002), rework (Cooper, 1993a,b,c) and concealing rework (Ford & Sterman, 2003b), schedule pressure (Cooper, 1994; Ford & Sterman, 2003a), and "fire-fighting" (Repenning, 2001). A complete dynamic hypothesis of development project failure would include unrealistic performance targets and how negative feedback loops that describe responses to schedule, budget, and other pressures can trigger fatal reinforcing loops through productivity losses, overstaffing, inadequate training, and other project behaviors. Other exogenous changes that slow progress, degrade performance, and can lead to failure (e.g., increased regulation, scope changes, temporary work stoppage) would provide the bases for additional hypotheses. The dynamic structure would also include the amplification of impacts due to delays in discovering rework that allow problems to be passed

¹ Active projects that stagnate, with no change in project backlog over time, are also considered failures but are less common. As will be shown, these conditions can be unstable, and stagnant projects are likely to shift behavior modes into an increasing or decreasing project backlog.

among development phases. These and other causes of project failure have been used in system dynamics practice, and several have been addressed in the literature.

The current work focuses on how a particular dynamic structure, tipping points, can cause a common project feature, ripple effects, to generate rework and project failure. A development project's ripple effects are the secondary or tertiary impacts of a change. Thomas and Napolitan (1994) identify indirect changes due to ripple effects due to work interdependency in construction projects as an important cause of project failure. They estimate the impacts on labor efficiency in some projects to be seven times larger than the impacts of direct changes. Ripple effects can be triggered by many unplanned events or conditions, including the exogenous factors described above. Likewise, ripple effects can have multiple types of impacts, including creating more work, requiring rework in previously correct work, and reducing productivity. We focus on the work effort created by ripple effects and disaggregate that effort into two forms, contamination and adding new tasks². Contamination is work required in part of the *existing* project scope that is created due to rework being discovered in a different portion of the project. For example, if after a reinforced concrete column was poured, the inspectors discovered that the reinforcing steel used was too small, part of the beams above and below the column might have to be demolished in order to replace the column. Replacing the column (rework) requires reworking the beams even though the beams were not otherwise defective. The column rework contaminated the adjacent beams, but did not add any *new* activities to the project. In contrast to contamination, adding new tasks, as used here, creates development activities *beyond* the project scope due to rework required on portions of the existing project scope. In the column example, temporary shoring required to support the upper beams while the column is replaced would be new tasks. Rework on previously created new tasks can also contaminate and add more new tasks. For example, inadequate temporary shoring of the beams in the column example could damage adjacent floors (contamination) and require more shoring for floor repairs (more new tasks). The critical difference between contamination and adding new tasks is that contamination creates more rework within the existing project scope or previously added tasks, while adding new tasks creates development activities that were not previously a part of the project. The current research focuses on adding new tasks because it can be difficult to identify during the course of a project when created by rework and, as will be shown, can cause challenging project behavior and failure.

Tipping points are one explanation of bifurcated system behavior such as project backlogs that diminish and lead to success or grow and lead to failure. A tipping point is a threshold condition that, when crossed, shifts the dominance of the feedback loops that control a process (Sterman, 2000). Systems tend to remain stable as long as conditions remain "below" the tipping point, and controlling feedback is dominant (Sterman, 2000, p. 306). But when conditions cross the tipping point, behavior can become (temporarily) unstable and, in the case of projects, lead to failure. Social physiologists have used tipping points to describe an unexpected spread of disease, a dramatic change in the crime rate in a city, and an increase in the number of teenage smokers despite a campaign of increased awareness (Gladwell, 2000). System dynamics can be used to elucidate tipping points and their impacts on systems in several ways: 1) by specifying, formalizing, and explaining structures that create tipping points, 2) by describing behaviors resulting from tipping points, and 3) by developing policies for

² As used here, *scope* refers to the tasks, measured in work packages, that, when approved and released, provide a specified performance; *work* is an amount of development effort, also measured in work packages. Rework and adding new tasks cause the work required to complete the project to exceed the scope.

managing systems with tipping points. Here we investigate whether a combination of a tipping point structure and ripple effects can explain the failure of some large, complex development projects.

The current work examines the generation of tipping point dynamics due to ripple effects in single project development systems and tests strategies and policies for resistance to project failure. Challenges posed by tipping points in single projects are discussed next. Two examples of tipping point failure in the nuclear power industry are presented. Then, a model of a single-product development project is used to examine the impact of ripple effects on project success. Exogenous, endogenous, and combined drivers of behavior modes are followed by testing policies for tipping point solutions, and the use of robustness as a measure of potential project failure is tested. The conclusion discusses managerial implications and research opportunities.

Project Management Challenges near Tipping Points

Complex development projects are difficult to manage because of the dynamic nature of project systems (Lyneis et al., 2001). A project manager's ability to understand these non-linear feedbacks is limited. Most project management tools available, such as the critical path method, are linear and cannot adequately predict the effect increased rework and added new tasks has on a project. Systems dynamics is more suited to the modeling of development dynamics. Such models must include iterative flows of work, distinct development activities and available work constraints both within and among development phases. The existing system dynamics models of projects (which include process structures) have focused on the roles of two development activities. Cooper (1994, 1993a,b,c, 1980) first—and several researchers subsequently (e.g. Kim, 1988; Abdel-Hamid, 1984; Richardson & Pugh, 1981)—modeled two development activities by distinguishing between initial completion and rework. This distinction allows the effect of rework on a project to be studied.

Similar structures and conditions may drive some individual development projects. Many product development projects are managed largely in isolation from other projects and can fail due to dynamics solely within or near a single project. Therefore, the explanation of tipping point impacts on project performance needs to be expanded to single project design and management. The current work extends the multi-project work by Repenning (2001) and Black and Repenning (2001) to single development projects. We use a system dynamics project model to examine the effects of ripple effect-induced tipping point dynamics on single project behavior and performance. This work contributes a new explanation for the failure of some large, individual development projects. The understanding of development project dynamics is advanced by proposing and initially testing the ability of a specific project structure to generate tipping point dynamics. That understanding is the basis for proposing and testing policies for preventing or managing projects that are vulnerable to failure due to tipping point dynamics.

Tipping Point Dynamics in Nuclear Power Plant Construction

The first commercial nuclear plant to come on-line in the United States was Dresden 1, located in Illinois, in 1959 (NRC, 1982). Between 1959 – 1969, twelve nuclear plants were completed with an average construction duration of 46 months (NRC 1982). Between 1970 – 1981, the average duration nearly tripled, reaching 131 months in 1981 (NRC, 1982). While the plants constructed during this time were higher capacity units (i.e., bigger) than earlier projects, most researchers identify the ever increasing (and ever changing) number of governmental regulations imposed on nuclear plants as the root cause for cost and duration increases in



nuclear plant construction (Lake, 2002; Kharbanda & Pinto, 1996; Feldman et al., 1988; Lillington, 2004; Friedrich et al., 1987). Examining construction records from the Nuclear Regulatory Commission from this period provide two examples of possible tipping point dynamic failure.

The first example of a project that crossed this tipping point is the Tennessee Valley Authority's (TVA) Watts Bar nuclear power plant units 1 and 2. TVA began the construction of the Watts Bar facility in December of 1972 (NRC, 1982). Originally the facility was to consist of two 1165 MW units that were to both be on-line by the middle of 1977 (NRC, 1982). However, as Figure 1 shows, the two units were unable to meet the planned deadline. By mid 1977, Unit 1 was 57% complete and Unit 2 was 49% complete. In May of 1974, the TVA reported delays due to the redesign of the reactor containment vessel to accommodate higher pressures, an inability to obtain redesigned anchor bolts and reinforcing rods, and increased time to erect steel plates that were thicker than the original specifications (NRC, 1982). The work created by the problems beyond the original scope (e.g., additional anchor bolts or steel plates) are evidence of adding new tasks. Work was halted in 1980 for five years to address worker safety concerns with the design of the plant (Lee, 1995). To address these concerns, the TVA spent nearly one million man hours reviewing the design of the plant (Lee, 1995). This review led to the replacement of nearly three million feet of cable, 8,000 pipe supports, and 25,000 conduit supports (Lee, 1995). The TVA canceled Unit 2 in 1995 with the unit 61% complete (Nuclear Engineering International, 1995). The TVA estimated that it would cost more than the \$1.7 billion already invested in Unit 2 to complete the unit. When Unit 1 finally came on line in 1996, the TVA had invested nearly \$7 billion dollars in the facility (Lillington, 2004). The decrease or stagnation in the fraction of the total project scope that has been completed (right side of Figure 1) is a characteristic behavior of projects experiencing strong ripple effects.

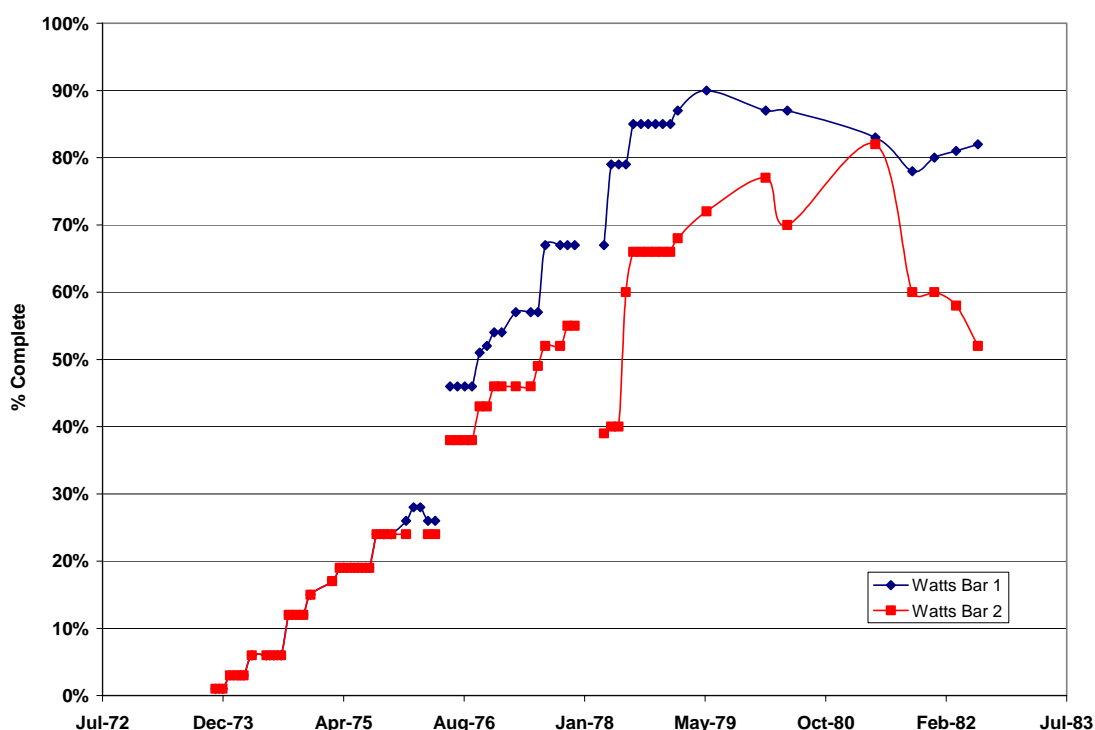


Figure 1. Watts Bar Construction Progression (1973-1982) (NRC, 1982)

The second example of tipping point failure is Philadelphia Electric's Limerick nuclear power plant. Construction of the two 1065 megawatt units began in June of 1974. The construction schedule at the issuance of the construction permit called for Unit 1 to be completed in April of 1979 and for Unit 2 to be completed in September of 1980 (NRC, 1982). The total estimated cost for both units in 1974 was \$1.2 billion (Days & Sellers, 1985). As Figure 2 shows, both units were well behind schedule at their respective planned completion dates (Unit 1 at 48% complete and Unit 2 at 36% complete) (NRC, 1982). Unit 1 finally came on-line in August of 1985, five and a half years behind schedule with a final cost of \$3.8 billion (Days & Sellers, 1985). Construction of Unit 2 was halted in July 1982 by order of the Pennsylvania Public Utility Commission due to escalating costs (NRC, 1982).

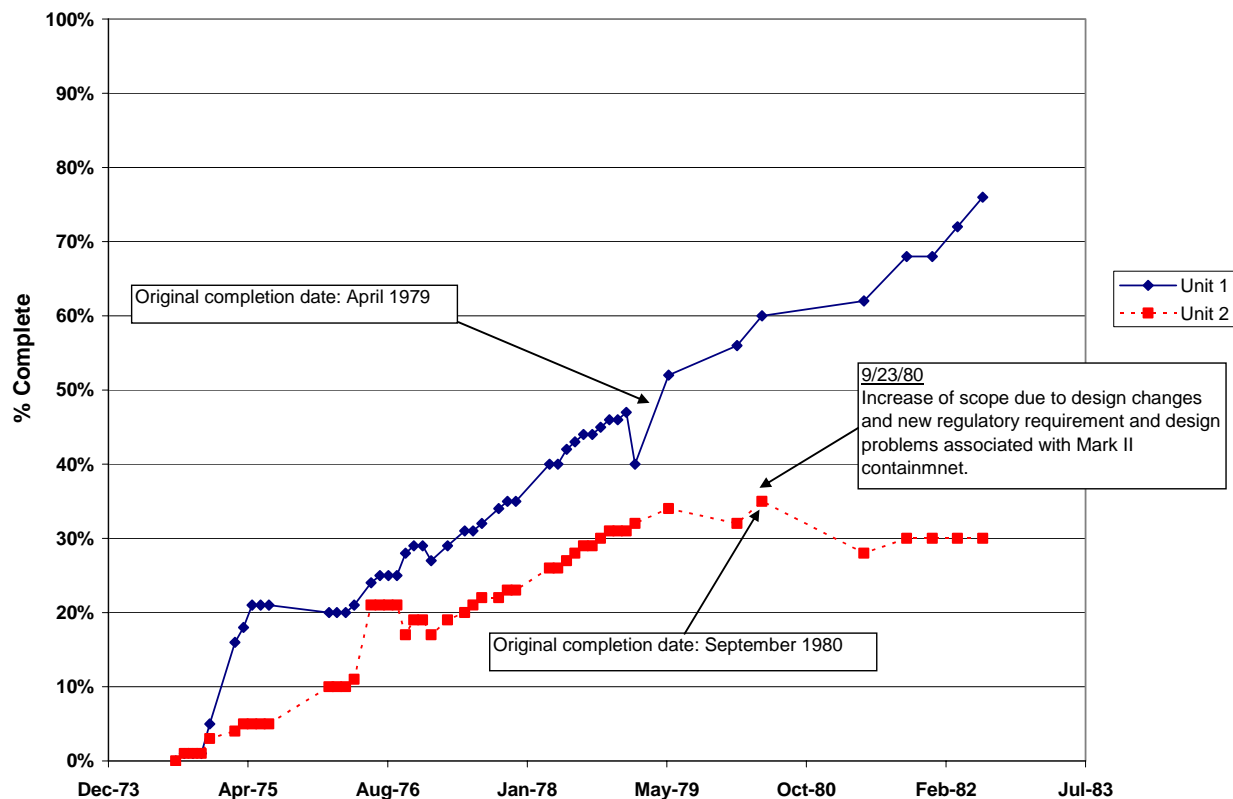


Figure 2. Limerick Nuclear Power Plant Construction (1974-1982) (NRC, 1982)

The Philadelphia Electric company attributed at least part of the cost and schedule problems to added new tasks and rework, two factors which Taylor and Ford (2006) showed capable of generating tipping point dynamics. In a September 1980 report submitted to the NRC, the estimated completion date was increased by two years for Unit 2 due to an “increase of scope [added new tasks] due to design changes and new regulatory requirements [rework]” (NRC, 1982). The degrading backlog behavior pattern is displayed on Unit 2 in Figure 2 between May 1979 and October 1980 as the percent complete begins to decrease. The Limerick plant was not the only plant to experience problems. A survey of senior managers at a firm specializing in nuclear plant construction revealed that nearly all surveys credited regulatory changes as the major cause for delays in both design and construction of nuclear power plants (Arditi & Kirsinikas, 1985).

The failure of Watts Bar and Limerick are not isolated incidents of nuclear plant project failure. An investigation of 45 nuclear power plants under construction between 1973 and 1982 revealed that only 2 of the plants finished at or before their original deadline. Figure 3 shows the frequency of schedule overrun for the 45 nuclear plants with the most frequent level of overrun between 100%-150% (NRC, 1982).

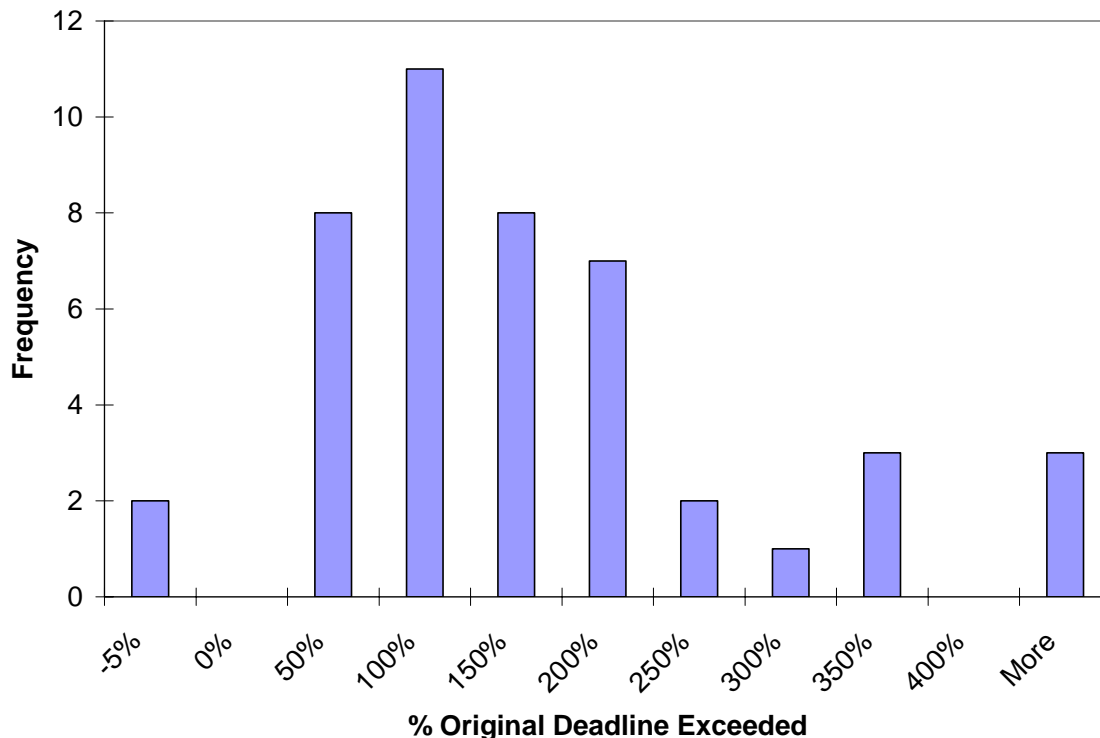


Figure 3. Schedule Overrun for Nuclear Power Plants (1973-1982) (NRC, 1982)

Further analysis of 52 nuclear plants under construction during 1977-1982 reveals that for 1370 total progress reports, 513 (37%) showed no net progress (i.e., stagnant backlogs) between report periods and 71 (5%) showed declining progress (e.g., increasing backlogs)—again behavior that could indicate the presence of tipping point dynamics.

A specific example of the effect of changing governmental regulation in nuclear plant construction is the changing requirements for pipe supports. In 1971, a new regulation was adopted that required all pipes within a nuclear power plant to be supported (Aron, 1997). This included pipes within the reactor containment building (the large concrete dome seen at all US nuclear plants). Designers failed to take into account the effect this change would have on plant design. One such example is the Shoreham plant in Long Island, New York.

Construction began in 1972 and was to be completed in the first quarter of 1977. In September of 1977, the expected duration was increased by over 12 months due to material shortages, labor productivity, and “design changes due to regulatory requirements” (NRC, 1982). The original estimate of \$217 million was well short of the actual \$5 billion cost when the plant was completed (Aron, 1997). Construction activities were completed in the mid 1980’s, but the plant never came on-line due to political pressure over concerns of evacuating Long Island in the event of an accident (Aron, 1997).

Although the plant did not begin construction until 1972, the design was already completed and approved before the new pipe support regulations took effect. According to a former Vice-President of the architect/engineering/construction firm building the Shoreham plant, during construction, the pipe supports had to be designed and installed (Reinschmidt, 2005). As these supports were outside the initial scope, they provide an example of adding new tasks.

Pipe support changes were not limited to the Shoreham plant. Friedrich et al. (1987) referred to the “reengineering and redesign” of pipe supports as a “frequently encountered event” in nuclear plant construction. Changing regulations along with changes in market conditions helped the economic viability of nuclear plants become suspect. A 1988 study (Feldman et al.) suggested that for most nuclear power plants under construction in the United States at the time, it would be more economical to either cancel the plants under construction, regardless of progress, or modify the plants to burn conventional fuel (coal, gas, or oil). This illustrates the potential large impact tipping point dynamics can have on single development projects.

A Simulation Model of Project Tipping Point Dynamics

Most traditional project-management models, such as the critical path method, are linear and cannot adequately predict the effects that increased rework, contamination, and the addition of new tasks have on projects. In contrast, systems dynamics is well suited to modeling development dynamics. System dynamics has a strong and established history of modeling development projects and has been successfully applied to a variety of project management issues, including failures in fast track implementation (Ford & Sterman, 1998), poor schedule performance (Abdel-Hamid, 1984), and the impacts on project performance of changes (Rodrigues & Williams, 1997; Cooper, 1980, 1993a,b,c) and concealing rework requirements (Ford & Sterman, 2003a).

The model is purposefully simple relative to actual practice to expose the relationships between tipping point structures, project behavior modes, and management. Therefore, although many development processes and the features of project participants and resources interact to determine project performance, only those features that describe a particular tipping point structure, project management policies, and the fundamental processes they impact are included. Simulated performances using different policies are, therefore, considered relative and useful for improving understanding and developing insights, but not sufficient for final policy design. Complete model equations and documentation are available from the authors or at <http://ceprofs.tamu.edu/dford/>.

The model consists of three sectors: a workflow sector (Figure 4), a resource allocation sector, and a schedule sector. The workflow sector is based on Ford and Sterman’s (1998) structure of a development value chain with a rework cycle. Work is initially completed and moves from the initial completion backlog³ (IC backlog) to the backlog of work requiring quality assurance (QA backlog). A fraction of the work checked by quality assurance is discovered to require change and moves into the rework backlog. Completed rework is returned to the QA backlog for checking again because rework can reveal previously hidden or create new change

³ Development activity flows represent the completion of a development task. Therefore backlogs, as used here, include work in progress.

requirements⁴. The complement of the checked work found to require rework passes quality assurance, is approved, released, and adds to the stock of work approved and released (Work Released). Flows between the stocks of IC backlog, QA backlog, RW backlog, and Work Released can be constrained by either process rates or resources. Process rates assume infinite resources and are the amounts of work available divided by the minimum times required to perform a work package. Resource rates are the products of the quantities of resources assigned to each activity and resource productivity. See Ford and Sterman (1998) for a more detailed work flow model description and model equations.

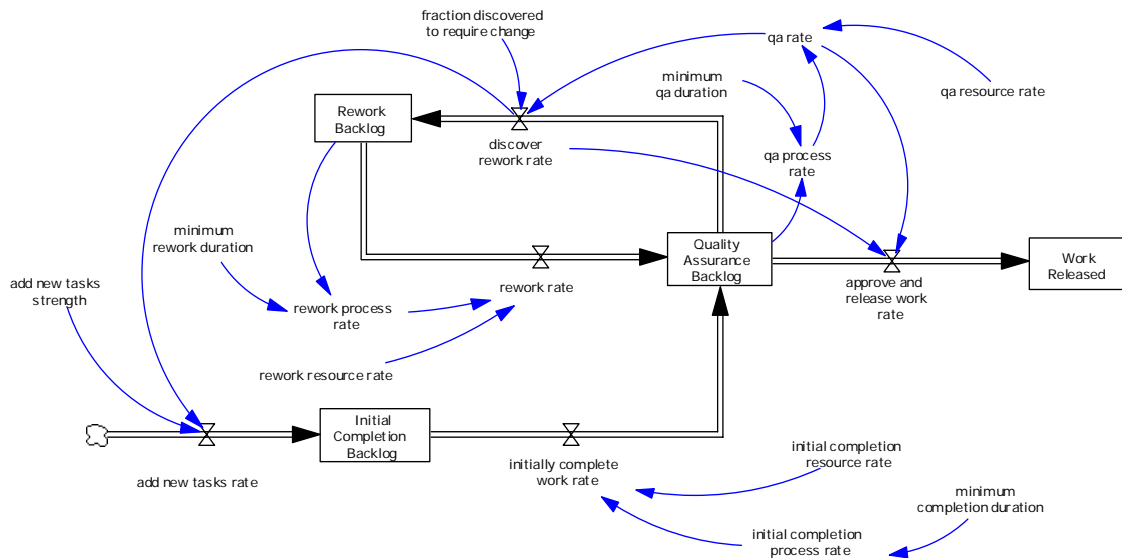


Figure 4. Work Flows for a Single Project System (based on Ford & Sterman, 1998)

A unique expansion of this model in the current work is the explicit modeling of adding new tasks in a tipping point structure. Adding new tasks creates work that is added to the IC backlog during a project. We assume that the amount of work created is proportional to the work discovered to require rework:

$$R_{nt} = (D_{rw}) (s_{nt}) \quad (1)$$

Where:

R_{nt} - rate of adding new tasks due to ripple effects {work packages / week}

D_{rw} - discover rework rate {work packages / week}

⁴ This creation of additional rework is not contamination because it represents additional rework required in the same piece of work, not additional rework required in a different piece of work.

s_{nt} – add-new-tasks strength {work packages created / work packages discovered, or dimensionless}

The add-new-task strength is a project characteristic that describes the amount of impact that reworked portions of the project have on the total work required to complete the project and, thereby, can be used to describe different project types. It is related to the amount of interdependence between project subsystems. For example, the strength between the foundation and superstructure components of a building would be high compared to the strength between the foundation and the heating system.

Resources are allocated among the initial completion, quality assurance, and rework activities proportionally based on the current demand for each of these activities. The desired fraction of resources for each activity is the size of the backlog compared to the project backlog (ICbacklog+QABacklog+RWbacklog). For example, if resource productivities are equal and the current RW backlog is 40% of the current project backlog, the desired portion of the available resources to be allocated to the rework activity is 40%. Applied resource fractions are delayed with a first order exponential adjustment toward the desired fractions to reflect reallocation delays.

Schedule pressure is common in development projects. Increased rework is a side effect of schedule pressure that can degrade project performance (Cooper, 1994; Graham, 2000; Ford & Sterman, 2003b).⁵ As a project approaches a fixed deadline, schedule pressure increases; developers increase the pace of work to meet the deadline. This increases the risk of work being completed incorrectly. In the schedule sector, pressure increases with the time required to complete the project backlog (t_r) and decreases with the time available to complete the project backlog (t_a). To explicitly model the impacts of schedule pressure on tipping point dynamics, we disaggregate the rework fraction (f_{rw}) into the sum of a reference rework fraction (f_{rw-r}) and the schedule-induced rework fraction (f_{rw-s}). The reference rework fraction reflects basic project complexity. The schedule-induced rework fraction is the additional fraction of work requiring change due to schedule pressure. The schedule-induced rework fraction reflects mistakes made by developers due to pressures to meet the project deadline. This portion of the rework fraction is modeled as the product of schedule pressure and the sensitivity of the rework fraction to schedule pressure (s_{rw-s}). Forgoing the functions to limit values to 0-100%, the rework fraction becomes:

$$f_{rw} = f_{rw-r} + f_{rw-s} = f_{rw-r} + [((t_r / t_a) - 1) (s_{rw-s})] \quad (2)$$

Where:

f_{rw} - rework fraction (dimensionless)

f_{rw-r} - reference rework fraction {dimensionless}

f_{rw-s} - rework fraction due to schedule pressure {dimensionless}

t_r - time required to complete project backlog {weeks}

⁵ Schedule pressure can have multiple beneficial and detrimental impacts on project performance which can be modeled with additional feedback loops (see Ford, 1995 for examples). The current work models only the net effects of schedule pressure on rework and assumes the net effect is negative.

t_a - time available to complete project backlog {weeks}

s_{rw-s} – sensitivity of rework to schedule pressure {dimensionless}

Figure 5 shows the work flow structure (Figure 4) and tipping point feedback structure. Feedback loop B1 (Project Progress) withdraws work from the rework cycle. The QA backlog increases due to initial completion and rework, causing the QA rate to increase as resources are shifted to quality assurance. Increasing QA increases the rate at which work is approved and decreases the QA backlog. This balancing loop drives the project to completion as the backlogs decline to zero. If no new tasks are added, B1 completes a project as quickly as processes and resources allow.

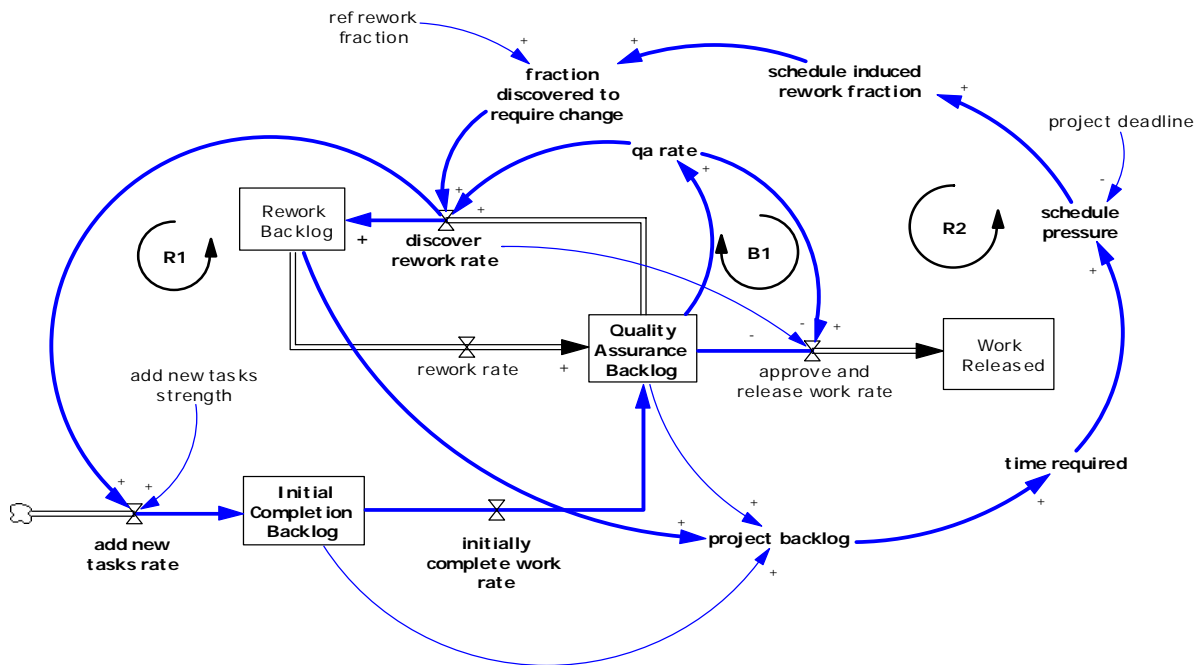


Figure 5. A Tipping Point Structure of a Single Development Project

Loop R1 (Add New Tasks) adds to the total work required to complete the project through increases in the discovery of rework and adding new tasks—increasing initial completion and, thereby, the QA backlog increases the QA rate, increasing the rate at which work is discovered to require rework. This increases the rate at which new tasks are added, thereby adding more work to the IC backlog. In the absence of loop B1 (e.g., if the rework fraction = 100%) loop R1 increases the rework and project backlog infinitely, thereby degrading project performance to eventual failure.⁶ Feedback loops B1 and R1 form a traditional tipping point structure that can dramatically change system behavior from being “under control” to being “out of control” due to a shift in feedback loop dominance from the balancing loop to the

⁶ The loop dominance analysis discussed here is consistent with the results of a more rigorous analysis performed using behavioral analysis presented in Ford (1999). See Taylor et al. (2005) for details.

reinforcing loop. We show how, through exogenous manipulation of loop dominance, managers can regain control of projects with tipping point structures. Loop R2 (Schedule Pressure) can increase the strength of the Add New Tasks loop (R1) by increasing the rework fraction as described above. The resulting increase in a project's backlog increases the time required to complete the project, increasing schedule pressure. This increases the schedule-induced rework fraction and, thereby, the fraction discovered to require rework⁷.

Model Testing and Typical Behavior

The model was tested using standard methods for system dynamics models (Sterman, 2000). Basing the model on previously tested project models and the literature improves the model's structural similarity to development processes and practices, as do unit consistency tests. Extreme condition tests were performed by setting model inputs, such as initial scope or total project staff, to extreme values and simulating project behavior. Model behavior remained reasonable. The model's behavior for typical conditions is consistent with previous project models and practice (e.g., the common "S"-shaped increase in work released over time shown in Figure 6). As a successful project progresses, the backlog initially decreases slowly as the value chain and rework structures fill with work, increases progress during stable production, and decreases to zero slowly as backlogs empty, indicating that the project is complete. Model behavior was also compared to actual project behavior as described by Ford and Sterman (1998; 2003b) and Lyneis et al. (2001) and found to closely match the behavior modes of actual projects.

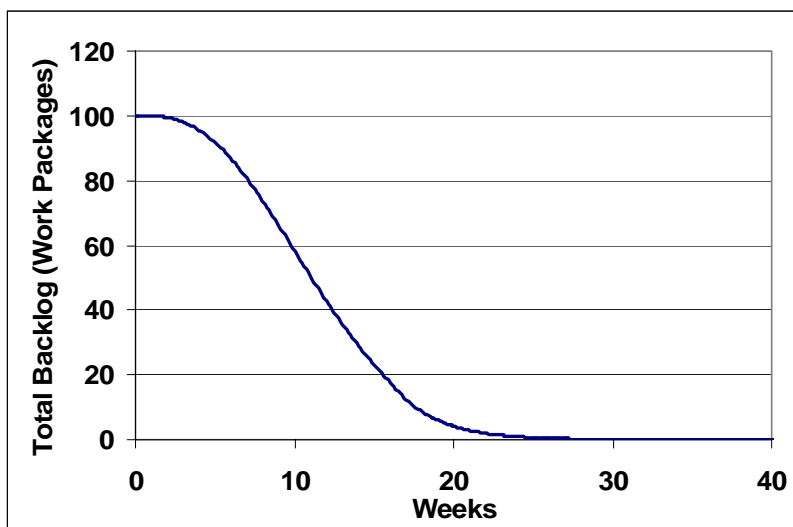


Figure 6. Typical Project Model Behavior

⁷ Third and fourth reinforcing loops exist in which the IC backlog and IC rate increase the QA Backlog and, thereby, the QA rate and Rework Backlog. These backlogs also increase the project backlog. These loops perform like loop R2, but instead of increasing the project backlog through the IC backlog, they increase it through the QA and Rework Backlogs.

Limited project data prevented calibration to a specific project that experienced tipping point dynamics. Therefore, to test the ability of the model to replicate tipping point behavior modes, the model was calibrated with reasonable values to reflect a hypothetical project in which the Add New Tasks and Schedule Pressure loops are active. The simulated behavior was compared to the behavior of the Tennessee Valley Authority (TVA) Watts Bar unit 2 project. The similarity between the actual project and simulated behavior modes in Figure 7 supports the model's ability to reflect a failure mode in nuclear power plant construction that could be caused by tipping point dynamics. Based on these tests, the model was assessed to be useful for investigating tipping point dynamics in single development projects.

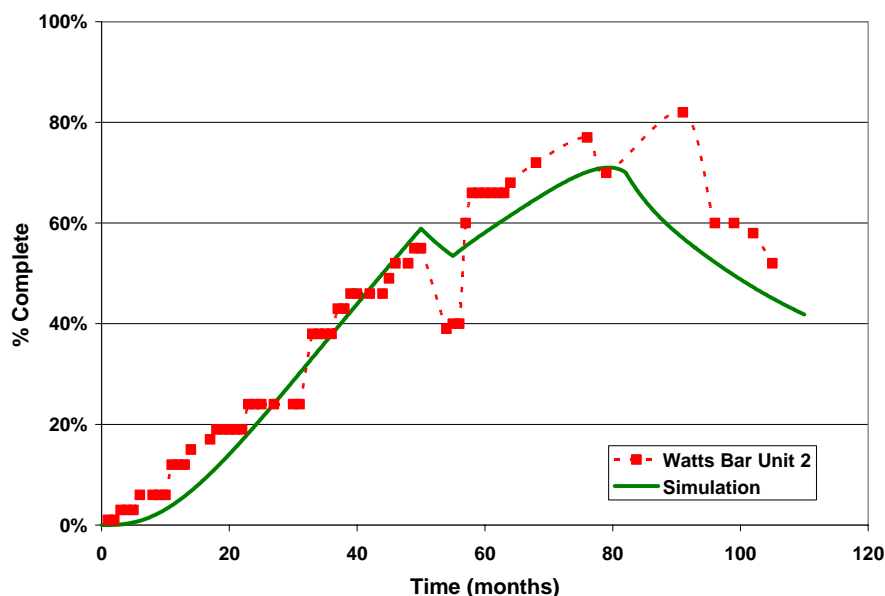


Figure 7. Tipping Point Behavior Mode Test

Similar to Repenning (2001), project progress is described with the project backlog as a fraction of the project's initial scope. Figure 8 shows the evolution of two types of projects. The horizontal axis shows project backlog in the previous time period; the vertical axis shows project backlog in the current time period. As an example of reading project behavior from the graph, the horizontal and vertical dashed lines show that in one project, the backlog was 80% of the scope in the previous time period and 72% in the current time period. All projects begin in the center of Figure 8, with backlog equals to their initial scope. *Improving* projects have decreasing backlogs and are reflected by conditions below the diagonal dashed line, when preceding project backlogs exceed the current project backlog. The behavior mode of the work released of the improving project in Figure 8 is the traditional "S-curve" common in project management literature. In contrast, *degrading* projects are reflected by conditions above the diagonal dashed line (when current project backlogs exceed previous project backlogs) and can theoretically have an ever-increasing backlog. The behavior mode of the project backlog of the degrading project in Figure 8 is an ever-increasing backlog. Successful projects end near the origin,⁸ when

⁸ The project simulation can reach the origin, when $(PB_{t-1}, PB_t) = (0,0)$, but actual projects stop when the backlog first reaches zero, when $(PB_{t-1}, PB_t) = (x,0)$ and $x > 0$. This is represented in Figure 6 by a point on the horizontal axis close to the origin.

there is no more project backlog. Failed projects approach the upper right corner of the graph, reflecting continuously increasing backlogs. A project that remains on any point along the diagonal line has a constant project backlog and is stagnant (in net progress terms). An upper limit describing project failure has been arbitrarily set at 2, when work remaining to be completed is twice the original scope. All simulations in the current work reaching this limit have continuously increasing total backlogs and are considered failures. However, this limit may need to be adjusted for some projects.

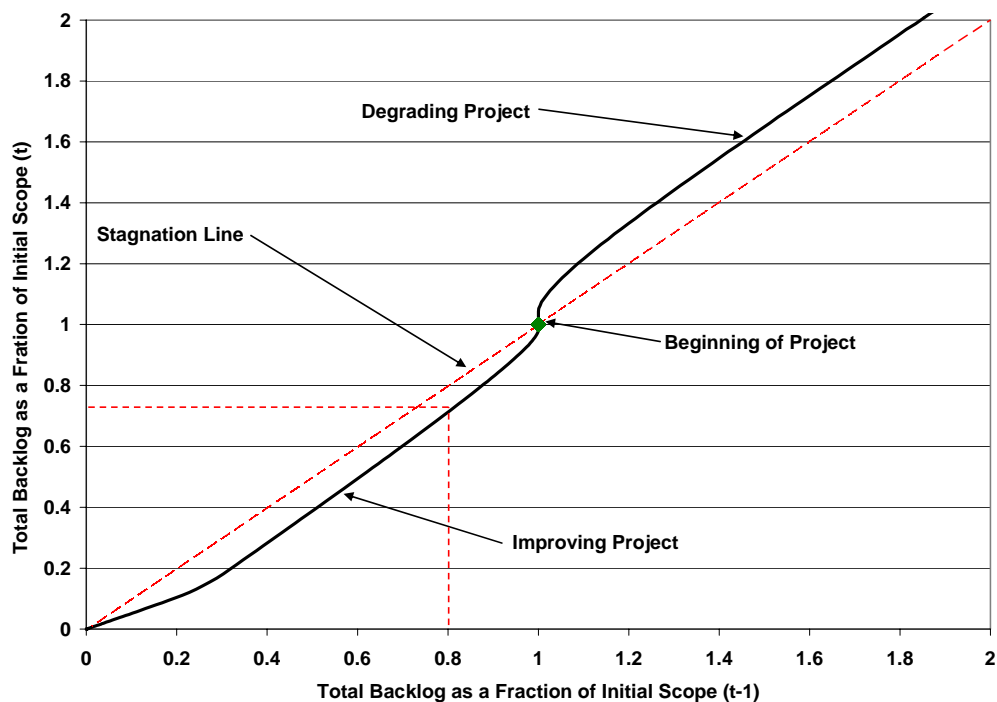


Figure 8. Evolution of Three Projects near a Project Tipping Point

In many projects, both loops B1 and R1 are active. In the improving project shown in Figure 8, the release loop (B1) is dominant; more work is being approved and removed from the rework cycle than is being added by new tasks through loop R1. For the degrading project, the Add New Task loop (R1) is dominant; more work is being added to the rework cycle than is being approved and released through loop B1. For stagnant projects (e.g. at the center of Figure 8), loops B1 and R1 are balanced; work is being removed from the rework cycle at a rate equal to the rate at which work is added to the rework cycle. The relationship between these two loops can be described using a tipping point.

Project Tipping Point Conditions

The tipping point is the condition between dominance by loop B1 (Figure 5) (leading to shrinking backlogs and project success) and dominance by loop R1 (leading to growing backlogs and failure). Adding new tasks adds work to the project backlog, and approving and releasing work withdraws work from the project backlog. Therefore, the tipping point occurs when the new task addition rate (R_{nt}) is equal to the rate at which work is approved and

released. The rate at which work is approved and released is the complement of the QA rate that is discovered to require rework (D_{RW})⁹. Therefore, at the tipping point:

$$R_{nt} = R_{QA} - D_{RW} \quad (3)$$

Where:

R_{nt} - Rate of adding new tasks due to ripple effects {work packages/week}

R_{QA} - quality assurance rate {work packages/week}

D_{RW} - discover rework rate {work packages/week}

Temporarily using the aggregate rework fraction (f_{rw}), the rework discovery rate (D_{RW}) is the product the QA rate (R_{QA}) and the rework fraction. By substitution using equation (1), equation (3) becomes:

$$(s_{nt})(R_{QA})(f_{rw}) = R_{QA} - (R_{QA})(f_{rw}) \quad (4)$$

Simplification yields a description of the conditions that define the tipping point.

$$f_{rw}(s_{nt} + 1) = 1 \quad (5)$$

When the left-hand side of equation (5) exceeds 1, the project is degrading, when less than 1 the project is improving, and when equal to 1 the project is stagnant. A project can only remain at a tipping point (i.e. $f_{rw}(s_{nt} + 1) = 1$) if loop B1 completes work at exactly the rate that loop R1 adds work to the project backlog. The project behavior will bifurcate to failure if loop R1 dominates or to success if loop B1 dominates. Therefore, the tipping point is an unstable equilibrium.

When the left-hand side of equation (4) exceeds 1 the project is degrading, when less than 1 the project is improving, and when equal to 1 the project is stagnant. The tipping point conditions are shown graphically in Figure 9.

⁹ See Rahmandad (2005) for a similar project structure with constant addition of work and constrained work approval and release.

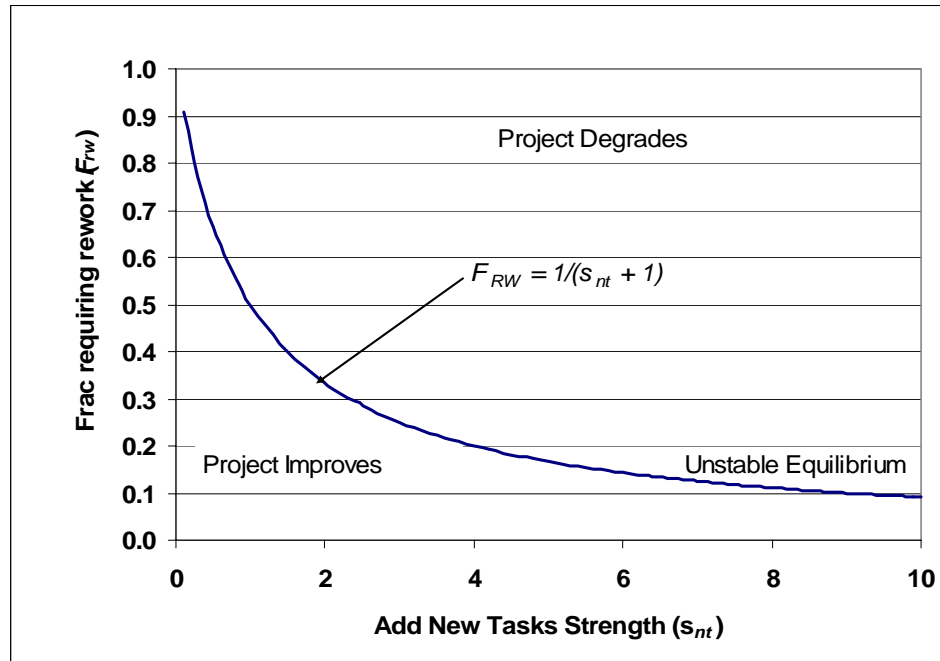


Figure 9. Basic Project Tipping Point Conditions

Figure 9 can be used to intuitively explain the behavior of projects near the tipping point. The total backlog of projects to the lower left of the solid line decreases, and the project improves. The total backlog of projects to the right of the solid line increases, and the project degrades. The solid line represents possible tipping point conditions. A project can only remain at a tipping point if the loop B1 completes work at exactly the rate as loop R1 adds work to the project backlog (Eq. 2). In the absence of forces to keep the project stagnate, small digressions from the tipping point conditions in either direction will cause the project to improve or degrade. If either loop dominates, total backlogs will increase (R1 dominates) to project failure or decrease (B1 dominates) to project completion. Therefore, the tipping point is an unstable equilibrium.

Project conditions that move across the tipping point conditions shown in Figure 9 experience a change in project behavior mode from increasing to decreasing or vice versa. The shape of Figure 9 reveals intuitive insights about project conditions that generate tipping point dynamics. The negative slope of the tipping point conditions line indicates that projects that have low add-new-task strength (s_{nt}) can tolerate a higher fraction of rework (F_{RW}) before degrading and projects with low rework fractions can tolerate higher add-new-tasks strengths. However, the tipping point relationship between add-new-tasks strength and rework fraction is not linear. A small increase in add-new-tasks strength greatly reduces the tolerable rework fraction. But as add-new-task strength increases, the tolerable rework fraction decreases more slowly, asymptotically toward a value of zero.

Project Trajectory Reversal and Schedule Pressure

We next investigate projects that begin on one side of the tipping point but, due to endogenous or exogenous influences, are pushed past the tipping point and reverse their behavior mode from improving to degrading or visa versa. As used here, project trajectory reversal is when the status of a project initially improves but later degrades and eventually fails

(i.e., when an improving, “good,” project degrades, “goes bad”) or vice versa. Project trajectories that are monotonically improving or monotonically degrading (e.g., Figure 8) do not describe trajectory reversal. However, our study of large complex construction projects such as nuclear power plants indicate that trajectory reversal is an important issue. If project resources and productivity are limited and fixed, the basic project tipping point structure described above cannot endogenously simulate projects with trajectory reversal. This is because the structure lacks a mechanism to shift feedback loop dominance from loop B1 to R1. Exogenous influences, additional endogenous dynamic structures, or both, are required to propel projects beyond the tipping point and reverse their trajectory.¹⁰

Exogenous Influences on Tipping Point Dynamics

Exogenous factors can influence the rework fraction or add-new-tasks strength, such as changes in project scope during construction or, as with the case of the nuclear plant, changes in requirements. An inspection of equation (5) shows that, if a project starts far enough away from its tipping point (e.g. $F_{RW} (s_{nt}+1) < 1$) and the increases in the rework fraction and add-new-tasks strength are small enough, that the project does not cross the tipping point and behaves essentially like a monotonically improving project. However, if the magnitude of the changes is large enough, the project could be pushed past the tipping point, causing a project that initially improved to reverse its trajectory and degrade. However, as will be demonstrated next, pushing a project beyond its tipping point is not always sufficient to trap the project there and cause project failure.

Figure 6 shows the behavior of a project that begins with $F_{RW} = 0.2$ and $s_{nt} = 1$. Applying equation (5) ($F_{RW} (s_{nt}+1) = 0.2(1+1) = 0.4 < 1$) places the project on the improving side of the tipping point (pt. 1 in Figure 10). The project progresses towards completion until, at week 10 the rework fraction was exogenously raised to 0.6 to reflect a new but temporary problem that the development team must address. The tipping point conditions jump to 1.2, pushing the project quickly past the tipping point (pt. 2 in Figure 10). The project degrades, and the project backlog increases. The project continues to degrade until the rework fraction is exogenously returned to the original condition and the tipping point conditions return to their original level (pt. 3 in Figure 10). Once the project is operating below the tipping point again, it begins to reduce the project backlog (pt. 4 in Figure 10), thus improving to completion (pt. 5 in Figure 10). This demonstrates how improving projects subjected to large but temporary exogenous increases in the rework fraction, add-new-tasks strength, or both can be pushed beyond their tipping point and begin to degrade. But, barring structures that prevent a full and immediate recovery of those factors, when the exogenous change is removed, the project crosses the tipping point again and can improve again.

¹⁰ Delays that can also cause shifts in feedback-loop dominance by temporarily constraining a strong loop are not addressed here.

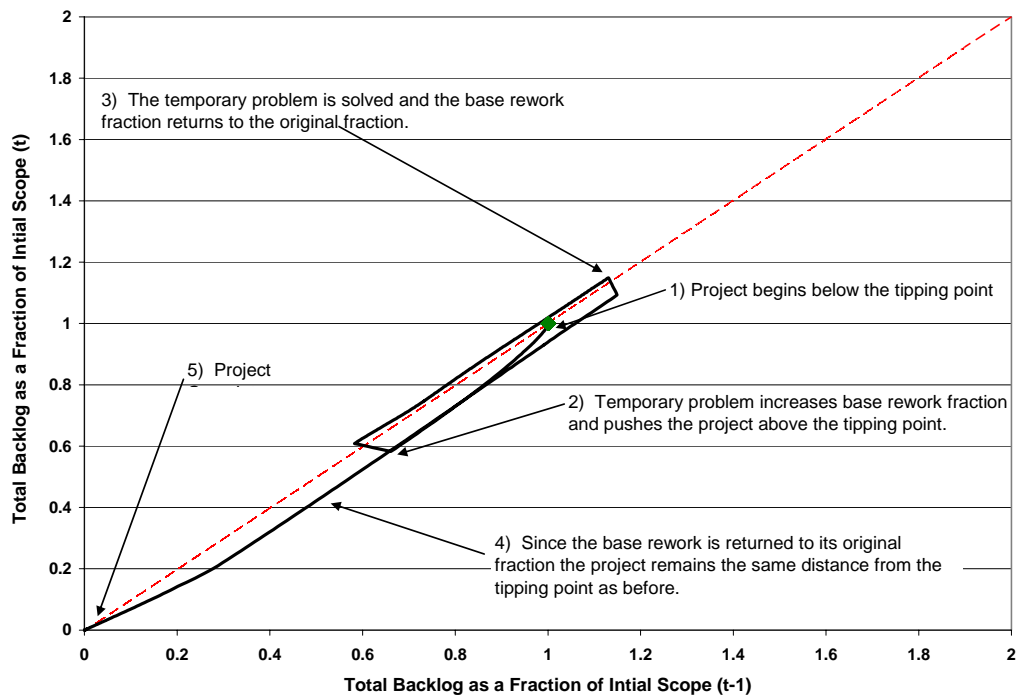


Figure 10. Project Exogenously Pushed beyond the Tipping Point

As modeled above, a sustained exogenous impact or another dynamic structure is required to cause an improving project to both reverse its trajectory and fail. In contrast to the behavior in the example above and in Figure 10, permanent exogenous changes in the rework fraction, add-new-tasks strength, or both that keep the project conditions beyond the tipping point (i.e. $F_{RW}(s_{nt}+1) > 1$) generate project failure. Simulations not shown here for brevity verify these results.

A side-effect of the temporary problem in the example above is that the project will have a longer duration than it would have if the rework fraction had not increased. The time projects spend beyond the tipping point increases the total required work. If resource quantities and productivity is limited, this can cause projects to be completed far later than without the trajectory reversal. But, given enough time, the project will finish. This may be a partial explanation of projects that are very difficult to terminate and have very poor schedule performance (such as the Department of Energy projects described previously). In other cases, economic or other types of deadlines may cause these projects to be terminated, such as with nuclear plants that were never completed (Nuclear Engineering International, 1995).

Endogenously Influenced Tipping Point Project Failure

Some projects reverse their trajectory from improving to degrading and fail with continuously increasing project backlogs due to temporary problems. This suggests that temporary problems influence projects after the problem is resolved in ways that can cause failure. Setting aggressive deadlines is common in development projects. This generates schedule pressure, which can cause performance problems in development projects (Lyneis et al., 2001; Ford & Sterman, 2003a). Here, we investigate the impacts of schedule pressure due

to aggressive deadlines on project performance through adding new tasks. Figure 11 shows the behavior of two projects (A and B) with different deadlines and, therefore, different amounts of schedule pressure. Without schedule pressure (feedback loop R2 inactive), the two projects finish in 25 weeks. The expected duration for project A has been reduced by 20% (20 weeks instead of 25 weeks). Project B has had its expected duration reduced by 28% (18 weeks). The interaction of schedule pressure and the tipping point have a dramatic impact on project performance. Project A remains on the improving side of the tipping point and finishes, but schedule pressure pushes Project B past the tipping point, causes trajectory reversal, and leads to failure. Simulations verify that the amount of schedule pressure that can be absorbed without trajectory reversal is related to the distance the project starts away from its tipping point conditions. These simulations demonstrate that projects can absorb safely some schedule pressure, but that in the presence of a tipping point structure, too much schedule pressure can cause projects to fail. The added new tasks—schedule pressure reinforcing loop provides an endogenous explanation for how projects that begin in conditions that can lead to success can become trapped beyond the tipping point, degrade, and fail.

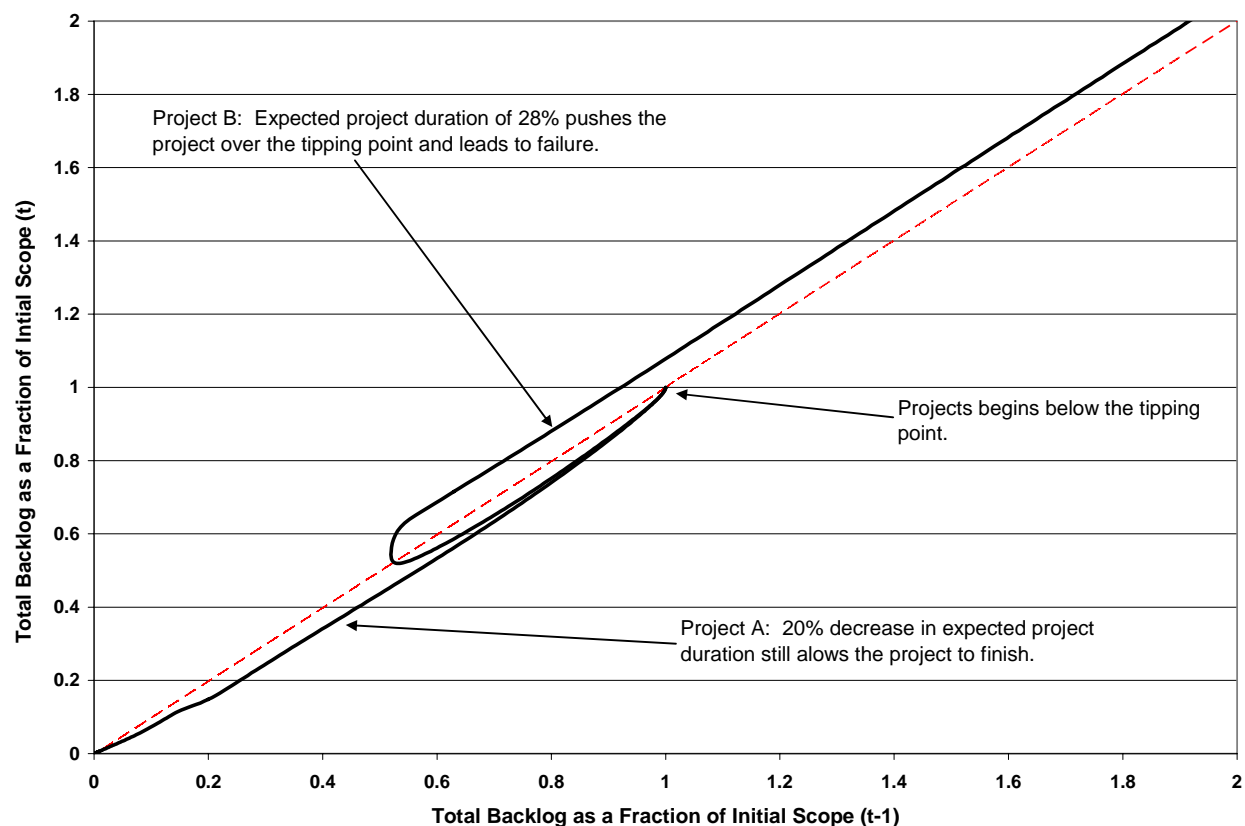


Figure 11. Effect of Schedule Pressure on Project Performance Mode

Compound Project Failure

Most development projects experience temporary problems, and many have aggressive deadlines. In these cases, as shown above, development projects can be doomed or likely to fail due to a tipping point structure. However, projects that can succeed despite temporary problems but do not are of particular interest to development project managers because they

provide opportunities for improvement. Schedule pressure can trap projects that would finish (under normal circumstances) beyond the tipping point and drive them to failure. Figure 12 describes such a project. When applied individually, a temporary problem (Figure 10) or moderate schedule pressure (Project A in Figure 11) do not initiate permanent project degradation to failure. However, their combined impact is enough to permanently push the project past the tipping point.

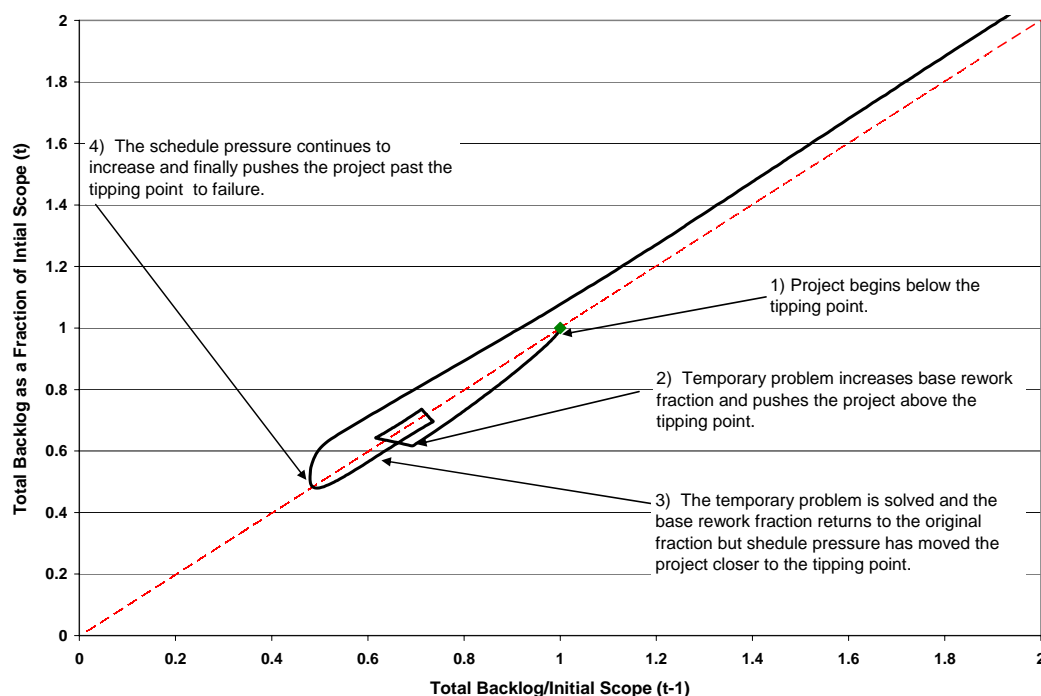


Figure 12. Interactive Impact of a Temporary Problem and Schedule Pressure on a Project

Consider a development project with an aggressive deadline that experiences an unexpected problem that temporarily increases the rework fraction. The project (see Figure 12) begins below the tipping point (pt. 1) and improves. In week 10, an exogenous temporary problem is encountered that pushes the project over the tipping point (pt. 2). The project begins to build project backlog, degrade, and increase schedule pressure. When the problem is resolved and the temporary increase in the rework fraction is removed, the project dips below the tipping point and begins to improve again (pt.3), but remains closer to the tipping point line than its previous position. This is due to the increased project backlog generated by the temporary problem; this increases the schedule pressure and, therefore, the rework fraction and added new tasks. In contrast to the project without schedule pressure, the rework fraction increases after the temporary problem is resolved due to the higher schedule pressure. This activates loop R2, increasing the addition of new tasks, project backlog, and schedule pressure. Eventually, project conditions exceed the tipping point again (pt. 4), and the project crosses the tipping point a second time, this time due to endogenous causes. The evolution of percent complete for this project is shown in Figure 13.

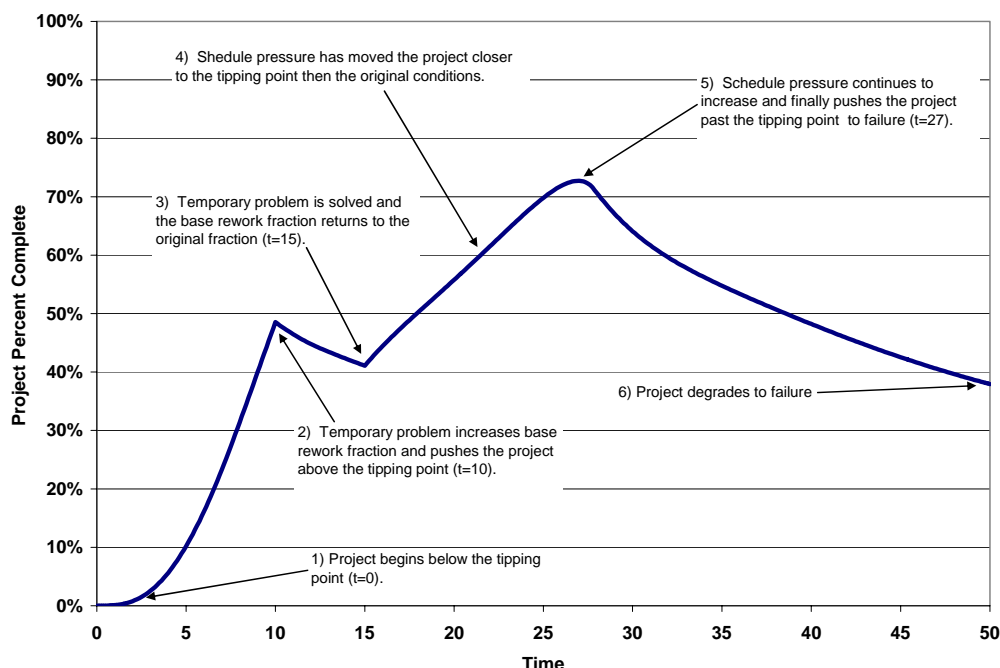


Figure 13. Project Trajectory Reversal Percent Complete

The behavior pattern in Figure 13¹¹ is similar to the behavior of the TVA's Watts Bar unit 2 project shown in Figure 1. This shows that the combination of a tipping point structure and ripple effects can cause projects to fail. A project experiencing this type of behavior (ever-increasing backlogs and decreasing percent complete) would be faced with making major changes (i.e., increasing resources, scope reduction, revising project deadline) or terminating the project. Either way, the project would likely be considered a failure (increasing costs, lost revenues due to delays) and negatively impact all involved entities.

We have demonstrated several scenarios in which an improving project can experience trajectory reversal and degrade to failure. Schedule pressure, an endogenous influence, can also push a project to failure. The experience shown in Figure 12 reflects a common problem that can be generated by a simple feedback structure. In the next section, we use this problem as the basis for testing strategies for managing development projects near a tipping point to avoid project failure or save projects that are degrading.

Project Management near Tipping Points

A review of current literature reveals several strategies for addressing tipping point failure in single development projects. These strategies for tipping point avoidance can be

¹¹ As defined for **Figure 13**, the Project Percent Complete is the work released as a fraction of the sum of the scope and added work. The Project Percent Complete can increase if projects are just slightly beyond the tipping point and if a large fraction of the new tasks added to the project backlog are simultaneously being approved and released. This can be shown by disaggregating the project backlog into the scope, total backlog added, and added backlog that is completed.

divided into avoiding tipping points through project design, resource management, backlog management, and schedule management.

Avoiding Tipping Points through Project Design

Avoiding tipping point conditions such as those described above entails the selection or design of development projects with relatively low rework fractions and added new tasks. Project selection may include an assessment of project complexity and interdependence and their impacts on the probability of success. Some projects or portions of projects may have characteristics that allow this strategy. For example, construction projects often use relatively simple technologies and processes to constrain rework fractions, and project planning purposefully keeps these operations separate to constrain ripple effects. Even projects with inherently high rework fractions and added new tasks can be designed to apply this strategy through methods such as modular design (Baldwin & Clark, 2000). Modular design develops projects as sub-systems that can be adjusted independently with minimal impact on the design as a whole. By designing projects with loose dependencies, if a design change does arise, it can be corrected with minimal impact on other systems. Figure 6 helps illustrate how a modular project with relatively low add-new-task strength would be able to tolerate a higher rework fraction without crossing the tipping point (i.e., it would reside in the lower-left of the chart). In the model, modular designed projects would have a lower add-new-task strength and would, therefore, be insulated from additional work added by the ripple effect. Modular design allows complex projects (with high rework fractions) to progress because a reduction in added new tasks has been designed into the project.

An example of modular design from the automotive industry is Toyota's method for designing components of a new car model. During the design of a new model, Toyota will provide their brake-system supplier with specifications regarding the weight of the car, the desired stopping distance from a given speed, and how much space the brake system can occupy in the wheel assembly (Womack et al., 1991). The brake supplier can change the design of the brake system without impacting other project components as long as the required specifications are met. This example demonstrates the concept of robustness which we apply to project design.

Robustness in Project Design

Taguchi et al. (2000) defines robustness as "the state where the product/process design is minimally sensitive to factors causing variability." The research of robustness in new product development has been largely limited to the robustness of the final product (Lou et. al., 2005; Swan et al., 2005). The current work expands the concept of robustness to project design and measures the protection that the robustness of a project provides from tipping point failure. An inspection of equation (5) suggests that, if a project starts far enough away from its tipping point (i.e. $f_{rw}(s_{nt}+1) < 1$) and increases in the rework fraction and the addition of new tasks strength are small, the project will not cross the tipping point and will monotonically improve. However, if the magnitude of the changes is large enough, the project could be pushed past the tipping point. By modeling robustness (r_{tp}) as the distance between project conditions and the tipping point, equation (5) can be rearranged to provide an intuitive meaning of project robustness against tipping point-induced failure:

$$f_{rw} + (f_{rw} \cdot s_{nt}) + r_{tp} = 1 \quad (6)$$

Where:



r_{tp} – project robustness to tipping point-induced failure {dimensionless}

The right side of equation (6) represents 100% of the project's capacity to tolerate additional new tasks. This capacity has been disaggregated into the three parts on the left side of equation (6): 1) capacity fraction absorbed by rework (f_{rw}), 2) capacity fraction absorbed by addition of new tasks ($f_{rw} \cdot s_{nt}$), and 3) the unutilized capacity fraction that provides robustness (r_{tp}). When r_{tp} is positive, the project is below the tipping point (improving); when it is zero, the project is at the tipping point (stagnant); and when it is negative, the project is above the tipping point (degrading). For example, suppose a project has a fixed 20% reference rework fraction ($f_{rw-r} = 0.2$) and a fixed add-new-tasks strength (s_{nt}) of 1. Applying equation (6), this project begins 0.6 from the tipping point (has an initial robustness of 60%). Given these conditions, the project could tolerate schedule pressure-driven increases in the rework fraction of up to 30% (making $f_{rw} = 50\%$) without crossing the tipping point.

Equation (6) also provides a means of analyzing the effects of different variables on project robustness. Robustness can vary significantly from initial conditions during a project. For example, schedule pressure can increase the fraction of work requiring change (f_{rw}) and, thereby, reduce robustness (equation 6). The minimum distance that project conditions come to the tipping point during the project represents a project's most vulnerable conditions. Therefore, a project's minimum distance from a tipping point is a better measure of project robustness than the initial distance. Figure 14 shows the results of a sensitivity analysis of project robustness to five variables that impact tipping point dynamics in the model.

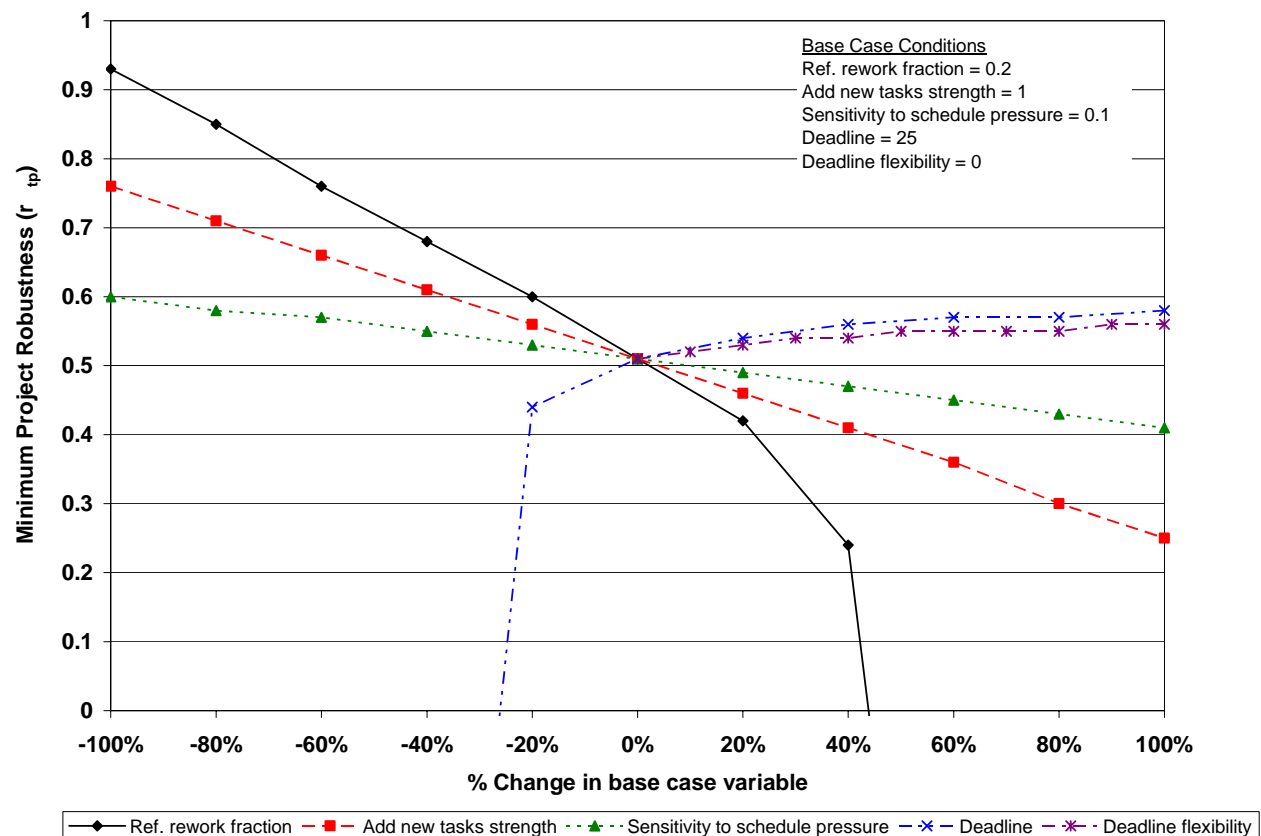


Figure 14. Sensitivity Analysis Results

The horizontal axis of Figure 14 represents the percent change from base-case values of the reference rework fraction, add-new-tasks strength, rework sensitivity to schedule pressure, deadline without flexibility, and flexibility of deadline. The vertical axis represents the project robustness or protection from tipping point-induced failure. For the base case, the robustness at the beginning of the project (60%) is reduced by schedule pressure during the project to a minimum of 51%. Values which “fall off” the bottom of the chart reflect negative robustness, when the project has crossed the tipping point and failed. The sensitivity analysis reveals two important features of the relationships between the control variables and minimum project robustness against tipping point-induced failure. First, with the exception of deadline flexibility, each variable has a threshold value, beyond which robustness quickly becomes negative. The threshold values for minimum robustness sensitivity to schedule pressure and add-new-tasks strength are 250% and 120% of the base-case conditions, respectively (not shown for clarity). In this analysis, deadline flexibility does not have a threshold value because the base-case project succeeds with no deadline flexibility. Therefore, adding flexibility cannot degrade performance. Second, within the robust ranges, the control levers vary in their impacts on robustness. By inspection of Figure 14, minimum project robustness is most sensitive to the reference rework fraction, then add-new-tasks strength, then rework sensitivity to schedule pressure, then deadline (inflexible), and is least sensitive to deadline flexibility.

Resource Management

Resource management includes altering the quantities of resources, their productivities, altering resource priorities to meet resource demands, anticipating future resource demands, and adjusting resources from current to needed applications. One reasonable response to a project that has crossed the tipping point is to add more resources to the project. The justification would be that since a project has more work, more resources are needed to complete the work. Model simulations show that increasing a project’s resource level when a project crosses the tipping point can “save” the project, but this must be approached carefully. If adding resources does not reduce the rework fraction adequately through increased expertise, (for example) reduced schedule pressure, or other factors, the tipping point dynamics remain effectively the same. This can often be the case. Brooks (1982) states that, “adding manpower to a late software project makes it later.” Likewise, if inexperienced resources are added to a project, particularly one that is complex, the amount of discovered rework could increase (Graham, 2000; Lyneis et al., 2001). In these cases, adding resources to a project that has begun to degrade would *increase* the rate of degradation. More resources making more mistakes would drive the project beyond the tipping point faster than fewer resources. Therefore, managers must be careful when adding resources to a project near tipping points.

Often the preceding strategy is unavailable because resource quantities for development projects are limited or fixed. A second strategy is to allocate resources to maximize the flows of work through the project. Certain backlogs could be given priority to resources based upon a manager’s understanding of the critical aspects of the system. Black and Repenning (2001) studied this policy in multi-project systems. Repenning (2001) argues that “creating ‘fire-resistant [tipping point resistant]’ [new product development] systems requires the development of more dynamic methods of resource planning.” He suggests that this planning method use the present state of the system to forecast the future resource needs. The basic model as described above follows this recommendation. In the basic model, managers are assumed to allocate the same fraction of resources to each activity as the activity’s *current* backlog contributes to the project backlog.



A simple and reasonable extension of this policy is to assume that managers base allocations on their forecasts of resource needs at a time in the future. This is consistent with Cooper's (1994) suggestion that "developing an information system to forecast resources committed to known projects as well as resource availability as a function of time is no easy task, but it is essential." Thomke and Fujimoto (2000) suggest shifting resources to earlier parts of projects as the key to success, stating "faster product development can be achieved with an earlier generation of problem-and-solution related information, particularly if it involves critical path activities." Joglekar and Ford (2005) use a control-theory model and system dynamics to evaluate the impacts of forecasting resource demand on project schedule performance. Sterman's (2000, p. 634-636) structure for modeling trends is adopted¹² and the resulting trend linearly extrapolated from current backlog sizes into the future, the time required to reallocate resources. Sterman (2000) describes and explains the model structure and the equations that govern the resource forecasting system.

Resource Management Impacts on a Degrading Project

We simulated the potentially successful project (that became trapped beyond the tipping point and failed) (Figure 12) across a range of resource adjustment times and demand forecasting policies from no forecasting to forecasting with long-time horizons. As shown in Figure 15, resource forecasting can save the project. The project begins below the tipping point (pt. 1). At some point, a temporary problem is encountered that pushes the project past the tipping point (pt. 2). Once this problem is resolved, the project returns below the tipping point. Schedule pressure pushes the project close to the tipping point (pt. 4) after the project recovers from the temporary problem. As RW and QA backlogs begin to increase, resources are shifted far enough in advance and fast enough to prevent the backlogs (through schedule pressure) from pushing a project across the tipping point. A policy that uses four weeks of backlog history to develop a trend that is projected four weeks into the future can save the project if adjusted quickly enough (≤ 4 weeks).

¹² The exception to the use of Sterman's trend structure is that only two exponential smoothing loops (rather than three) are used. Sterman's structure uses the third exponential loop to smooth "noisy" data fed into the structure. The input data to our structure is already smooth, so this third loop is unnecessary.

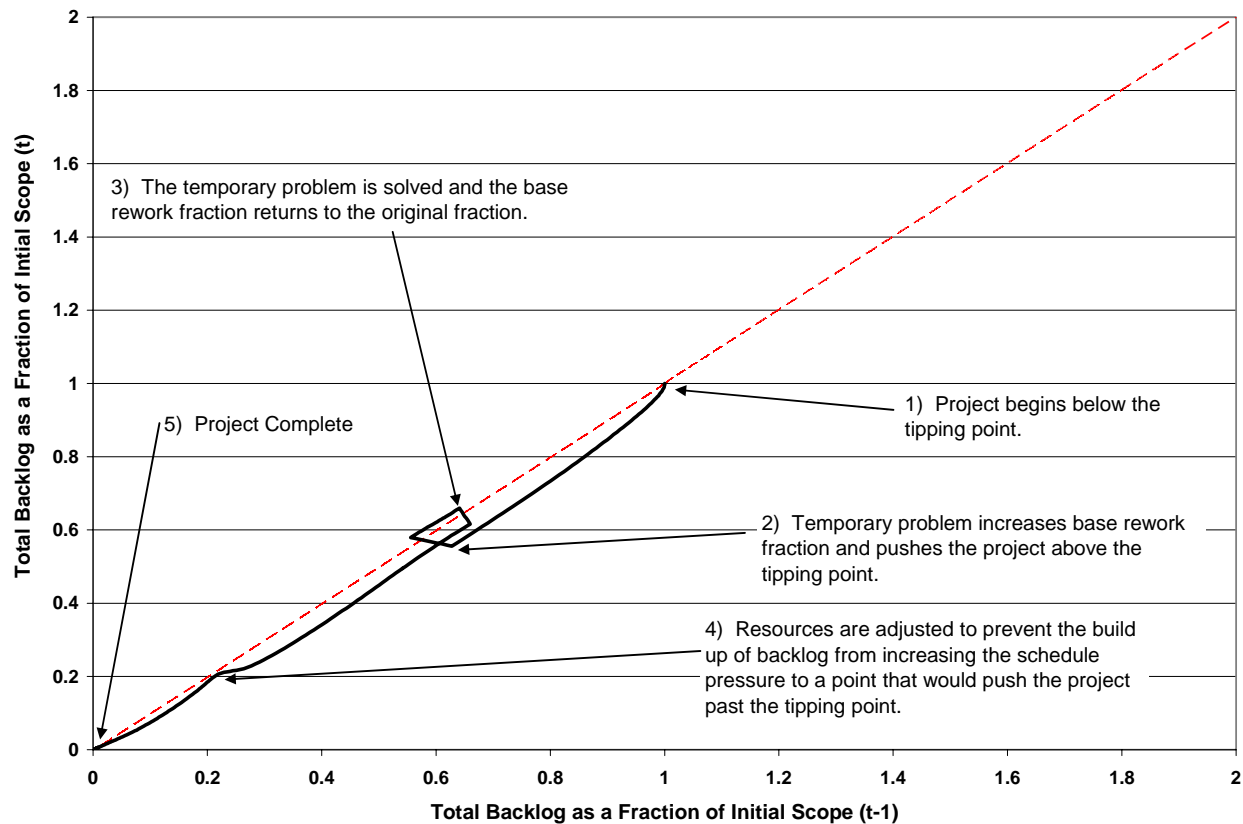


Figure 15. Use of Resource Forecasting to Save Project

Initial results show that longer trend adjustment times (i.e., a slow reacting manager) prevent the trend from reacting quickly enough to the increases in backlogs to allow resources to be allocated fast enough to save the project. Shorter trend adjustments (i.e., a quick reacting manager) pull the project farther away from the tipping point. This suggests that managers should react quickly to changes in project work backlogs.

Resource Adjustment Times

The time required to shift resources across development activities also impacts performance. Lee, Ford, and Joglekar (2004) found that resource adjustment times can have important impacts on project schedule performance. Their model simulations identified that there exists optimal resource adjustment times that minimize project duration over a range of project complexities. Reducing resource adjustment times while still utilizing proportional resource allocation policies can also save the project. Figure 16 shows the problem project (Figure 12) with a resource adjustment time reduced from 4 weeks to 3 weeks. Faster adjustments of resources towards target levels cause the schedule pressure to decrease after the removal of the temporary problem (Figure 16 pt. 4) and saves the project from continuous degradation (Figure 16).

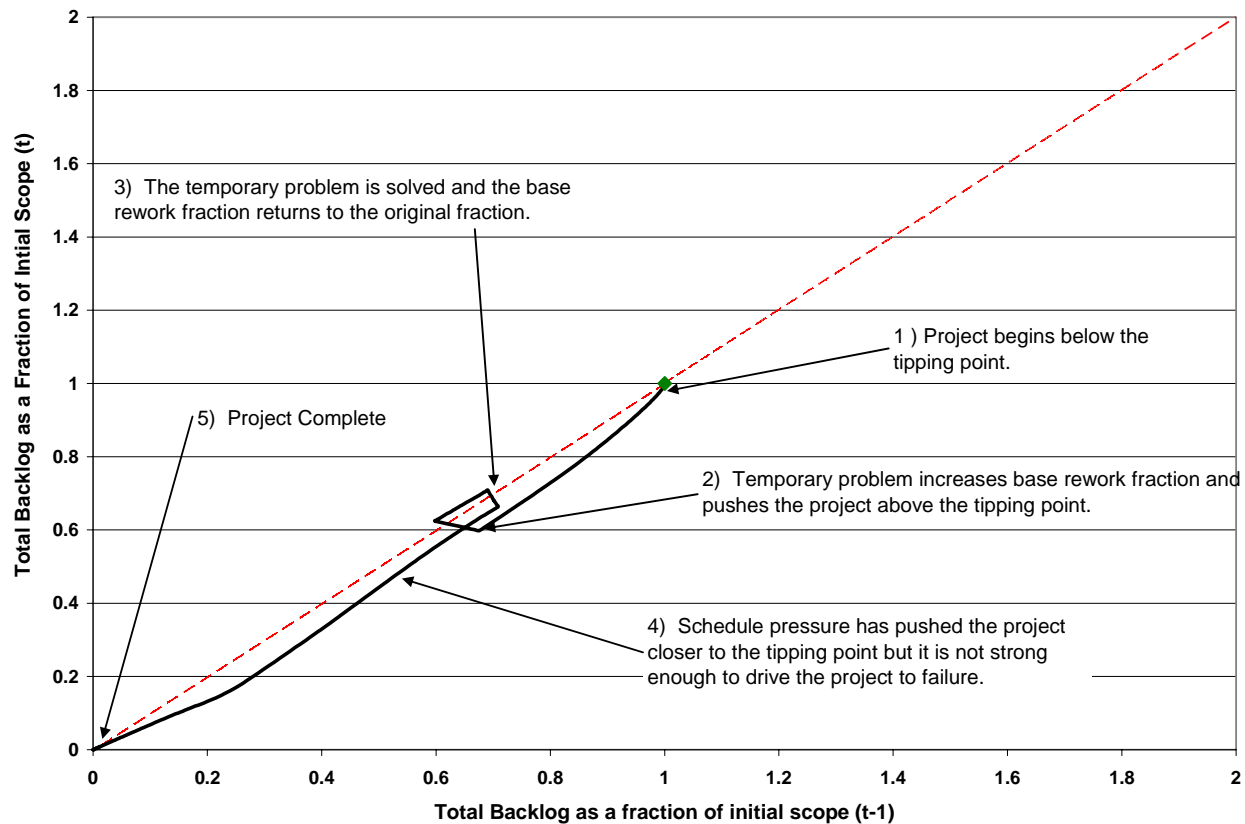


Figure 16. Use of Decreased Resource Adjustment Time to Save Project

Both resource forecasting and reduced staff adjustment times provide managers levers that can be used to save failing projects. Forecasting resources is somewhat straight forward, provided a manager can make a reasonable estimate of expected future work. From the authors' own experience the success of this policy is highly dependant on the accuracy of the estimate. One must also ensure that a change in the projected trend is reflective of changing resource requirements. Reducing staff adjustment times can be more challenging than resource forecasting, but appear to have a greater impact.

Backlog Management

Backlog management involves canceling work or releasing defective work. Work cancellation is a reduction during the project of features or scope of a project. Model simulations (not shown here for brevity) show that, if enough work is canceled, that canceling defective work can prevent a project from being overwhelmed with rework. As expected, projects nearer the tipping point required the cancellation of more work than those farther away. Black and Repenning (2001) found similar results using work cancellation in a multi-project system.

Schedule Management

One factor that controls schedule pressure is the project deadline. Both Cooper (1994) and Graham (2000) argue that setting realistic project deadlines reduces the amount of rework on a project. Therefore, an important part of schedule management is monitoring the project

deadline and ensuring that it is realistic. One way to ensure a realistic deadline is to implement a flexible deadline. A flexible deadline is dependent upon the amount of work left to be completed in a project. A rigid deadline does not take into account changes or delays in a project caused by rework and added new tasks. Flexible deadlines take these effects into account by adjusting the expected completion date based upon the time required to complete the total project backlog. To model this flexibility, the project deadline moves toward the expected completion date at a rate based on the flexibility of the deadline and the difference between the expected completion data and deadline. The effectiveness of flexible deadlines in saving the problem project (Figure 12) was tested. Figure 17 shows how a flexible deadline prevents the increased backlog due to the temporary problem from increasing schedule pressure. This prevents schedule pressure from building up to a point that would drive the rework fraction high enough to push the project beyond the tipping point. This suggests that managers can use deadline flexibility to recover projects from degradation initiated by crossing a tipping point.

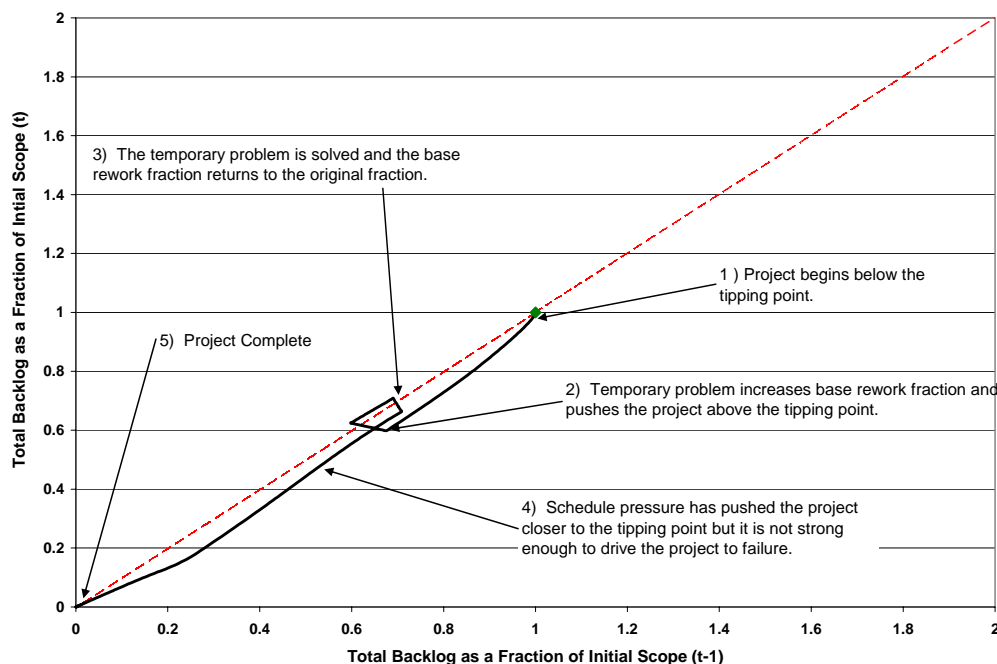


Figure 17. Use of Flexible Schedule on Project Past the Tipping Point

Tipping-point Management in the Nuclear Plant Construction Industry

Unlike Watts Bar #2, Limerick Unit #2 was ultimately completed. A review of the methods used to complete the unit reveals the use of several of the tipping point management policies previously discussed. Construction of Limerick Unit #2 was resumed in February of 1986, and the unit was completed by August of 1989 by Bechtel. To complete the unit, Bechtel implemented several of the solutions previously presented. The overall backlog to be completed was reduced by eliminating many of the required pipe supports through an advanced support design (Clarey, 1987) illustrating the use of backlog management. Bechtel also increased the non-manual manpower on the project by 300% a year before increasing the manual workforce. Nearly two-thirds of this increase was in the form of engineering and construction management personnel (Clarey, 1987) which improved the project's work planning. Once manual work

began, all complex installations were thoroughly reviewed by engineers to reduce overall rework, and design engineers were placed on all working shifts to resolve any constructability issues that arose (Clarey, 1987). This illustrates the concept of increasing manpower in a way that potentially reduces the rework and ripple effects of the project.

Conclusions

Tipping point structures are integrated with single development project dynamics to examine project behavior modes. The tipping point is useful because it allows comparison of project failure due to different causes. Rework and the addition of new tasks can combine to push projects to fail. By understanding these failure mechanisms, potentially robust policies are examined that can decrease the risk of failure for projects near the tipping point threshold. Successful policies were those that avoided the tipping point by reducing rework and ripple effect or those that reduced backlogs by effectively managing resources.

The policies tested provide several managerial implications. Tipping point conditions (Eq. (4)) support the use of modular design in the development of complex products. By reducing the ripple effect, modular design would allow more aggressive projects to be pursued with reduced risk of failure. As described in the discussion of Toyota's brake system design, modular design allows concurrent development of project tasks with minimal interdependence. Project managers would benefit from preliminary designs which set project specifications to allowing concurrent modular design. The work also contributes a preliminary test of robustness as a measure of future project performance. Our results show that robustness may be a good measure of a project's protection from tipping point failure. Future research in this area should focus on operationalizing robustness for use across a wide range of project types. This future work could provide project managers with a method of evaluating the failure potential of projects.

Proper resource management can play an important role in project success. Resource forecasting (with quick identification of changing trends) has the potential to further insulate projects from the tipping point. Model simulations show that the most successful policies are those which are short in hindsight and forecast farther into the future. However, one limit of the model used here is that it benefits from data free of the "noise" typically associated with actual project tracking reports. Managers must be careful to ensure that a perceived project trend change is an actual change in project progression and not normal oscillations in project progress reporting before adjusting resources.

Resource adjustment times were also found to be potentially effective in responding to projects vulnerable to tipping point dynamics. Quicker adjustment times for both proportional and forecasted resource allocation policies were beneficial in preventing projects subject to schedule pressure from crossing the tipping point. Again, the model is limited in that it does not take into account the negative effects (worker morale, lost production time, etc.) of shifting resources. Other work (Lee et al., 2004) has shown that there is an optimal adjustment time for resources, remaining below which can be detrimental to a project. While flexible resources can be beneficial to a project, the key for managers is to ensure that resources are be adjusted in an efficient manner.

Finally, realistic deadlines can help prevent a project from being overwhelmed with schedule pressure. Managers need to carefully consider how changes in work volume, through either increased rework or scope changes, affect a project's deadline. Model simulations show that managers should resist the temptation to strive for schedules which have become



unrealistic due to drastic changes in a project's work volume. This is supported by other research (Lyneis et al., 2001; Graham, 2000).

The model structure used in this work has several limitations. This includes the assumption that all work released is of one quality. This prevents a policy investigation similar to Black and Repenning (2001) of releasing lower quality work in a single project system. In addition, the model does not take into account work that must be redone due to rework. Improved models that take into account these conditions are needed to fully examine policies that govern single project development. Future research can improve model structure consistency with actual projects and calibrate the model to practice.

Tipping point dynamics can strongly influence the behavior and performance of individual development projects, and sometimes determine their success or failure. Continued improvement in the understanding of tipping point dynamics can lead to better development, project management and performance.

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Panel – Service Contracting

Thursday, May 18, 2006	Service Contracting
12:45 p.m. – 2:15 p.m.	<p>Chair:</p> <p>Pierre Chao – Senior Fellow and Director of Defense Industrial Initiatives, Center for Strategic and International Studies.</p> <p>Papers:</p> <p><i>Managing the Services Supply Chain in the Department of Defense: Opportunities and Challenges</i></p> <p>Uday Apte, Naval Postgraduate School</p> <p>Geraldo Ferrer, Naval Postgraduate School</p> <p>Ira Lewis, Naval Postgraduate School</p> <p>Rene Rendon, Naval Postgraduate School</p> <p><i>What Works Best when Contracting for Services? An Empirical Analysis of Contracting Performance</i></p> <p>Sergio Fernandez, Indiana University</p> <p><i>Performance Based Service Acquisition: A Quantitative Evaluation of Implementation Goals and Performance in the United States Air Force</i></p> <p>Lt Col Curtis G. Tenney, USAF, Air Force Institute of Technology</p> <p>Capt Dylan D. Pope, USAF, Hill AFB</p> <p>Lt Col Bryan J. Hudgens, USAF, Naval Postgraduate School</p> <p>Lt Col David R. King, USAF, Headquarters, AF Program Executive Office</p>

Chair: Pierre Chao, Senior Fellow and Director of Defense Industrial Initiatives, Center for Strategic and International Studies.

Mr. Chao is a Senior Fellow and Director of Defense—Industrial Initiatives. Before joining CSIS in 2003, Pierre was a managing director and senior aerospace/defense analyst at Credit Suisse First Boston from 1999-2003, where he was responsible for following the US and global aerospace/defense industry. He remains a CSFB independent senior adviser.

Prior to joining CFSB, Pierre was the senior aerospace/defense analyst at Morgan Stanley Dean Witter from 1995-99. He served as the senior aerospace/defense industry analyst at Smith Barney during



1994 and as a director at JSA International, a Boston/Paris-based management-consulting firm that focused on the aerospace/defense industry (1986-88, 1990-93). Pierre was also a co-founder of JSA Research, an equity research boutique specializing in the aerospace/defense industry. Before signing on with JSA, he worked in the New York and London offices of Prudential-Bache Capital Funding as a mergers and acquisitions banker focusing on aerospace/defense (1988-90).

Pierre garnered numerous awards while working on Wall Street. Institutional Investor ranked Pierre's team the number one global aerospace/defense group every year eligible from 2000-02, and he was on the Institutional Investor All-America Research Team every year eligible from 1996-2002. He was ranked the number one aerospace/defense analyst by corporations in the 1998-2000 Reuters Polls, the number one aerospace/defense analyst in the 1995-99 Greenwich Associates polls, and appeared on the Wall Street Journal All-Star list in four of seven eligible years.

In 2000, Pierre was appointed to the Presidential Commission on Offsets in International Trade. He is also a guest lecturer at the National Defense University and the Defense Acquisition University. Pierre has been sought out as an expert analyst of the defense and aerospace industry by the Senate Armed Services Committee, the House Science Committee, Office of the Secretary of Defense, DoD Defense Science Board, Army Science Board, NASA, DGA (France), NATO and the Aerospace Industries Association Board of Governors.



Managing the Services Supply Chain in the Department of Defense: Opportunities and Challenges

Presenter: Uday Apte is Professor of Operations Management at the Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA. Before joining NPS, Apte taught at the Wharton School, University of Pennsylvania, Philadelphia, and at the Cox School of Business, Southern Methodist University, Dallas. He is experienced in teaching a range of operations management and management science courses in the Executive and Full-time MBA programs. Areas of Apte's research interests include managing service operations, supply-chain management, technology management, and globalization of information-intensive services. He has published over 30 articles, five of which have won awards from professional societies. His research articles have been published in prestigious journals, including *Management Science*, *Journal of Operations Management*, *Decision Sciences*, *IIE Transactions*, *Interfaces*, and *MIS Quarterly*. He has co-authored one book, *Manufacturing Automation* and has completed work on another co-authored book, *Managing in the Information Economy*.

Apte holds a PhD in Decision Sciences from the Wharton School, University of Pennsylvania. His earlier academic background includes a MBA from the Asian Institute of Management, Manila, Philippines, and Bachelor of Technology from the Indian Institute of Technology, Bombay, India. Prior to joining academia, Apte managed information technology and operations functions in commercial banking, insurance and utility industries for over ten years. He has also consulted with several major US corporations and international organizations including IBM, Texas Instruments, Nokia, Kinko's, Nationwide Insurance, Nations Bank and The World Bank.

Geraldo Ferrer is Associate Professor of Operations Management at the Naval Postgraduate School. Prior to joining NPS, he was in the faculty of the Kenan-Flagler Business School at the University of North Carolina for seven years. His areas of expertise include global operations, supply-chain management, sustainable technologies, product stewardship, reverse logistics and remanufacturing. He has also studied the reverse logistics required in recycling and remanufacturing operations and inventory problems affecting products made in small batches for frequent deliveries. He has published on these topics in *European Management Journal*, *Management Science*, *Naval Research Logistics*, *IIE Transactions*, *Production and Operations Management*, *European Journal of Operational Research*, *International Journal of Production Economics*, *Ecological Economics*, *Business Horizons* and *Resources Conservation and Recycling*. He is a contributor in the *Handbook of Environmentally Conscious Manufacturing* and *Handbook of Industrial Ecology*. He has presented his research in national and international conferences in four continents, and in invited seminars in various academic institutions.

Dr. Ferrer serves as reviewer for the National Science Foundation, many academic journals, and for the Social Sciences and Humanities Council of Canada. He has also reviewed textbooks in the areas of operations management, inventory management and project management. He received his PhD in Technology Management from INSEAD, his MBA from Dartmouth College, a Mechanical Engineering degree from the Military Institute of Engineering in Rio de Janeiro and a BA in Business Administration from Federal University of Rio de Janeiro. Dr. Ferrer was founder and director of Superserv Ltd., a company that promoted technology transfer ventures between North American and Brazilian business, introducing



innovative technology products for the petroleum industry. He has consulted for companies in the United States and in Brazil.

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Dr. Rendon has earned professional certifications from the National Contract Management Association (NCMA), the Institute for Supply Management (ISM), and the Project Management Institute (PMI). He has received the prestigious Fellow Award from NCMA, and he was recognized with the United States Air Force Outstanding Officer in Contracting Award. He has also received the NCMA National Education Award, the NCMA Outstanding Fellow Award, and the NCMA Charles J. Delaney Memorial Award for the best published article on contract management. Dr. Rendon is the Chair of ISM's Federal Acquisition and Subcontract Management Group, a member of the ISM Certification Committee, as well as on the Editorial Review Board for the ISM Inside Supply Management. He is a member of the NCMA Board of Advisors, as well as associate editor for its *Journal of Contract Management*. Dr. Rendon has published articles in *Contract Management*, the *Journal of Contract Management*, *Program Manager*, *Project Management Journal*, and *PM Network*, and is co-author of *Contract Management Organizational Assessment Tools* published in 2005.

Abstract:

The DoD's services acquisition volume has continued to increase in scope and dollars in the past decade. Between FY 1999 to FY 2003, the DoD's spending on services increased by 66%, and in FY 2003, the DoD spent over \$118 billion or approximately 57% of total DoD's procurement dollars on services (GAO, 2005b). In recent years, the DoD has spent more on services than on supplies, equipment and goods, even considering the high value of weapon systems and large military items (RAND, 2004). These services belong to a very broad set of activities ranging from grounds maintenance to space launch operations. The major categories



include professional, administrative, and management support; construction, repair, and maintenance of facilities and equipment; information technology; research and development, and medical care.

As the DoD's services acquisition volume continues to increase in scope and dollars, the agency must keep greater attention to proper acquisition planning, adequate requirements definition, sufficient price evaluation, and proper contractor oversight (GAO, 2002a). In many ways, these are the same issues affecting the acquisition of physical supplies and weapon systems. However, the unique characteristics of services and the increasing importance of services acquisition offer a significant opportunity for conducting research in the management of the service supply chain in the Department of Defense.

The objectives of this exploratory research are to (1) analyze the size, structure and trends in the DoD's service supply chain, (2) understand the challenges faced by contracting officers, program managers and end-users in services acquisition, (3) develop a conceptual framework for understanding and analyzing the supply chain in services, and (4) provide policy recommendations that can lead to more effective and efficient management of the DoD's spending on services. Addressing issues related to theory and practice, this research makes a modest contribution towards more effective and efficient management of service acquisition in the Department of Defense.

Keywords: service supply chain, outsourcing, contract management

Introduction

The DoD's services acquisition volume has continued to increase in scope and dollars in the past decade. Between FY 1999 to FY 2003, the DoD's spending on services increased by 66%, and in FY 2003, the DoD spent over \$118 billion or approximately 57% of total DoD's procurement dollars on services (GAO, 2005b). In recent years, DoD has spent more on services than on supplies, equipment and goods, even considering the high value of weapon systems and large military items (RAND, 2004). These services belong to very broad set of activities ranging from grounds maintenance to space launch operations. The major categories include professional, administrative, and management support; construction, repair, and maintenance of facilities and equipment; information technology; research and development, and medical care.

As the DoD's services acquisition volume continues to increase in scope and dollars, the agency must keep greater attention to proper acquisition planning, adequate requirements definition, sufficient price evaluation, and proper contractor oversight (GAO, 2002a). In many ways, these are the same issues affecting the acquisition of physical supplies and weapon systems. However, there are important differences between the production, acquisition and delivery of services and manufactured goods. For example, service activities cannot be inventoried, require customer contact and joint production, and have customer-specific inputs. Moreover, we observe intangibility in varying degrees, which makes it difficult to evaluate the quality and performance of a service operation (Karmarkar & Pitbladdo, 1995). The unique characteristics of services and the increasing importance of services acquisition offer a significant opportunity for conducting research in the management of the service supply chain in the Department of Defense.

The purpose of this research is, therefore, to conduct an initial exploratory analysis of DoD services acquisition so as to frame the totality of the DoD's services acquisition



environment. Our research contributes to both the theory and practice of service acquisition in the Federal Government. Theoretical contributions include the development of a conceptual framework for understanding and analyzing the supply chain in services, based on rigorous literature in operations management, logistics, public policy, budgeting and microeconomics. We expect that the knowledge developed herein will lead to more effective and efficient management of the Department of Defense acquisition of services.

This exploratory research effort consists of a review of the service acquisition practices in the Department of Defense. It includes visits to a sample of DoD installations involved in the acquisition of services, with interviews of contracting officers, program managers, and other personnel at these installations.

The literature review focuses on secondary sources such as government reports, defense acquisition-related periodicals and journals, and other scholarly as well as practitioner-oriented journals and periodicals dealing with service operations, outsourcing and contracting.

The DoD installation visits were planned to cover a sample of Army, Navy, and Air Force installations. Thus far, we have visited Travis AFB and the Presidio of Monterey with visits to the Naval bases in San Diego planned in the near future. These DoD installations have outsourced significant operation support services and provide an excellent source for analysis. During these visits, we explored the following research questions:

1. What types of base operations services are typically procured at military installations?
2. How is the outsourcing decision made in services acquisition?
3. How are these services acquired (what type of acquisition strategy and procurement method is used?)?
4. What are the challenges in procuring base operations support services, from both business (acquisition, finance) and operational (military, mission) perspectives?
5. What type of management structure is used to manage these service programs?
6. What are the emerging trends in the policies and practices used in acquiring base operations services?

This research paper is organized in six sections. This introductory section is followed by the second section dealing with the inherent characteristics of services and their implications to contracting. We analyze the size and structure of DoD's service acquisition environment in the third section. An overview of services contract management is also presented in this section. The fourth section presents our analysis of the DoD's policy and practices on contracting for services. The information we gathered during our site visits is discussed in the fifth section. The preliminary observations and conclusions of this exploratory research are given in the sixth and the final section. We wish to clarify that this is an ongoing research project with several activities such as additional base visits and interviews of contracting personnel and customers yet to be completed. Hence, this paper should be viewed more as an "interim report" rather than as a complete paper.



Service Characteristics and their Implications to Contracting

Service production differs from manufacturing in several ways. In many operations texts, the key issues that are identified include the intangibility of service output, the difficulty of portability, and complexity in the definition and measurement of services (for example, see Fitzsimmons & Fitzsimmons, 2006). To these we would also add the observation that services often involve joint production between the buyer and the supplier. These characteristics create certain differences in the production and marketing of services. For example, the joint production aspect means that the productive system is often not buffered from the customer. The customer is often present and even participating in the production process, while simultaneously being a consumer. The resulting need for "customer contact" has been analyzed in the seminal work of Chase (1981) to categorize different types of service firms and sectors. In this section, we examine the effect of some of the special characteristics of services on issues-related outsourcing of services and contracting for service delivery.

Characteristics of Services

There is a growing body of literature on operations management in service firms. Special characteristics of service operations are discussed in textbooks such as Sasser, Olsen and Wyckoff (1978), Murdick, Render and Russell (1990), Heskett, Sasser and Hart (1990), Lovelock (1992b), Fitzsimmons and Fitzsimmons (2006), and in casebooks including Sasser, Hart, and Heskett (1991).

Managing quality in service businesses, although similar in spirit to that in manufacturing, is somewhat different and is relatively more challenging due to certain inherent characteristics of service operations. These include the *intangibility of service outcome in some cases* and the *presence and participation of customers in the creation of many services*. Intangibility of outputs results in difficulties in matching demand and supply since such output can't be inventoried. This is, however, not meant to suggest that lack of inventory is a characteristic of services. In fact, as exemplified by a restaurant, managing inventory of supplies (termed as tangible goods by Sasser, Olsen & Wyckoff, 1978) can be very critical to the success of a service enterprise.

The *diversity* of services makes it difficult to come up with generalizations that are helpful for managers of service businesses. Lovelock (1983) proposes five schemes for classifying services that offer insight for marketing and operations managers in different service businesses. Additional suggestions for managing service business are given by Lovelock (1992a), Schmenner (1986), and Quinn (1992).

Chase (1981) proposed a theory of the *customer contact* approach to services which holds that the services that entail high degrees of customer contact have inherently smaller potential for efficiency due to the variability and uncertainty that customers introduce in the creation of service. Apte and Mason (1995) propose that customer contact be conceptualized in two ways: first, in terms of propinquity, or a physical presence, involving a face-to-face contact between the customer and service provider, and second, in terms of a symbolic contact where the main purpose of customer contact is to exchange the information necessary in service creation and consumption. It should be noted that a service activity, in general, requires a combination of both types of customer contact. With the progress of information technology, the symbolic portion of the contact is being increasingly automated using information technology. In many cases, information technology is also being used for redefining, or reengineering, services.



Closely related to the concept of customer contact is the service characteristic of *co-production*. Not only do customers have a presence during the service creation process, but they may have significant tasks to perform as well. Examples range from self-service at gasoline stations and salad bars to the shared responsibility for communication in diagnostic services and tailored financial services (including tax preparation). In some cases, the customer's participation in joint production is rather passive. But in other cases, such as financial planning or education, the participation may be very active and very significant in determining the quality of service production. Indeed, education is a major service sector for which an active role of the customer is absolutely critical. In the prototypical manufacturing case, customers' roles start after production has been completed. To the extent this is not the case—for example, custom production of manufactured goods with customer-provided blueprints—the manufacturing business takes on more of the character of a service.

As mentioned earlier, many services have outputs that are *intangible* and are *hard to measure* (McLaughlin & Coffey, 1990). For example, in services such as medical examinations or tax planning, output is quite intangible. Output of sales transactions involving manufactured goods can be metered rather easily with respect to the quantities involved. However, the delivered "quantity" of business consulting or medical services is rather more difficult to measure. In such cases, it is difficult for the buyer and the vendor to easily agree on exactly what output has been supplied. A serious confounding problem is that it is difficult to distinguish between the level of attributes of services and the quantity of services. For example, it may be hard to say whether medical advice is more correct, more thorough, more considerate of the patient, or simply more.

In textbook discussions of service operations, services are often described as being *complex*. A part of this complexity arises from the difficulties in measurement discussed above. A second part arises from the joint production or custom character of many services, which in turn has two effects: First, the presence of the customer means that the service process cannot be separated from service output. The obvious consequence is a much larger set of attributes for customer evaluation. Moreover, the customer brings to the process a set of expectations, capabilities, as well as material inputs that are specific to that customer. As a result, the "output" of the process as perceived by the customer may involve many customer-specific attributes. Participation in the production process is in itself a complex issue with some internal costs but possibly some consumption value as well. All these threads may be very difficult to untangle. As an example, consider a class in a management course, with the students (possibly organized into groups) and instructors interacting in the course of a case discussion. It is near impossible in practice to measure the educational output received by any one student in an objective way either in terms of quantity or attribute levels.

The special features of services lead to significant differences in the process of production, sale and consumption of services. These, in turn, have implications for market structure, pricing, and contracting for services. Karmarkar and Pitbladdo (1993) present some key features regarding service contracting that are relevant to the development of a service quality model. First and foremost, service operations are always post-contractual. Fixed-price contracts centered on output specifications can fail on two accounts. First is the difficulty of conceiving or verifying meaningful output specifications, and second is the variability of customer inputs and joint production which makes fixed-price contracts risky for the firm even when the output specifications can be well defined. Alternatively, contracts based on process specifications, such as time and materials, can turn out to be unsuitable since these can be risky for customers. These dual risks for firms and for customers can be addressed via stage-wise or contingent contracting, where the process is broken into stages, and the price for a



given stage is made dependent on the outputs of previous stages. For example, there may be a fixed fee for a diagnosis, and a fixed fee for treatment which, however, depends on the outcome of the diagnosis. The uncertainty in customer inputs is resolved by the diagnosis before it materializes in terms of treatment cost.

Service Quality

Corporate experience indicates that customer satisfaction and high service quality leads to greater long-term profitability (Buzzell & Gale, 1987). The topic of service quality, therefore, has received increasing attention during the last few decades. Deming (1985) and Crosby (1979) are notable examples of practitioner viewpoints on quality management. Gronroos (1982) is one of the early research papers that explicitly dealt with service quality. Adopting a customer's viewpoint, service quality is conceptualized by Parasuraman, Berry, and Zeithaml (1985) as the difference between the service quality expectations of a customer and the quality of service delivery performance as perceived by a customer. A detailed discussion of their service quality model and the associated survey instrument, SERVQUAL, can be found in Zeithaml, Parasuraman and Berry (1990). Other research literature on service quality includes comprehensive collections of readings such as Bowen, Chase and Cummings (1990), Brown, Gummesson, Edvardsson and Gustavsson (1991) and Lovelock (1992b). Chase and Bowen (1991) discuss service quality issues in terms of three elements of service delivery system: technology, systems and people. Apte, Karmarkar and Pitbladdo (1996) provide a new framework for measuring and improving service quality. In discussing the measurement and management of service quality, Collier (1990) examines the issues of definitions, standards and measurement, monitoring and control of service quality.

The main conclusions of these papers are:

- Customers find it more difficult to evaluate the quality of service as compared to the quality of goods.
- Customer evaluation of service quality involves comparison of a customer's expectations with actual service performance.
- Service quality evaluations are based on the outcome of a service as well as the process of service delivery.

Service Characteristics and their Implications to Contracting

Intangibility of service outcomes makes it difficult to clearly describe and quantify services, and, therefore, to contract for services. Consider for example, the difficulty in writing a contract for an educational service involving academic lectures. How does one define a “pound of education” and how can one be sure when the contract is fulfilled satisfactorily? As Karmarkar and Pitbladdo (1994) explain, this is the reason why, in such cases, we do not contract around quantities at all; rather we contract around process delivery. In general, the more information-intensive the service is, the more difficult it is to develop clear and meaningful contracts. This difficulty is somewhat reduced in services where physical objects play a dominant role.

Intangibility of outputs also makes it *difficult to define and measure quality*. For example, even for a simple custodial service such as cleaning, it is not easy to define the desired level of cleanliness. The levels of cleaning needed for an office is certainly different than for a hospital



operating room. The desired time duration for maintaining a clean status can also be an important matter in writing a contract for cleaning service. As research in service quality has found, customers typically evaluate the quality of service based on the outcome of a service as well as the customer's experience with the process of service delivery. For example, in a dining facility, not only must the food be tasty but the manner in which the food is served must also be courteous, prompt and friendly. This means that the contracts for many services should not be based solely on outcomes but should include specifications on both the outcome and the customer's experience with the process.

Co-production requiring presence and participation of customers in the creation of many services is an important characteristic of services. For example, in an IT service such as software development, a customer's input in terms of desired specifications of a software system is critically important. For example, however competent the software developer may be, the developed software will not be satisfactory if the specifications do not accurately reflect the true needs of the customer. Hence, the contracts for services should ideally specify not only what the service provider should do but also what the customer should do. Otherwise, a satisfactory service outcome may not be realized.

Diversity of Services also makes it difficult and undesirable to use the same contract vehicles or procedures for different services. For example, given the differences in medical services versus custodial services, it is important that the contracts for these services are customized to suit the lifecycle needs of individual services.

Finally, services are complex and may involve multi-stage processes. This makes it important yet challenging to write contracts that are flexible enough to cover all relevant scenarios and eventualities. Moreover, if such contracts cannot be satisfactorily defined, it may be desirable to deliver certain services using internal resources as opposed to outsourcing them.

Size and Structure of the DoD's Services Acquisition Environment

The DoD's procurement process is currently undergoing a transformation similar to the one experienced by private enterprises. This transformation is changing how the agency manages its procurement function to include its people, processes, practices, and policies. The DoD's procurement function is currently transforming from a transaction-oriented perspective to a strategic-oriented organization. No longer viewed as a tactical, clerical, or administrative function, the procurement function is gaining enhanced status as leading organizations understand its importance in achieving strategic objectives and its impact on competitive advantage. Specifically, the procurement transformation is taking place in three major areas: "moving from buying goods to buying services, moving from a command and control relationship to a partnering relationship between the government and contractors, and moving from a paper-based procurement system to electronic procurement" (Abramson & Harris, 2003, pp. 4-5). This research paper focuses primarily on the first transformation area: services acquisition.

The transformation from buying goods to buying services is considered the driving force behind the procurement revolution. Gansler describes this transformation as a reflection of the changing role of the government from that of a "provider of goods" to that of a "manager of the providers of good and service" (Gansler, 2003, p. 5). In addition, the method of procuring services is also changing. Traditionally, through the Request for Proposal (RFP), the government would dictate what the contractor was to do and how to do it. Through the use of detailed specifications and requirements, the contractor was directed how to perform the



contracted effort. The procurement transformation is changing how the RFP is being developed. RFPs are now being written to communicate the performance objectives or end-results of what the contracted effort needs to achieve, not how the work is to be done (Denhardt, 2003).

These two driving forces, the change in what the government is buying (services) and how the government is buying (performance-based contracts), is resulting in the government procuring solutions and knowledge, as opposed to specific supplies or standardized services (Denhardt, 2003, p. 6).

Growth and Scope of DoD Service Contracts

The federal government is the largest purchaser in the world: every 20 seconds of each business day the federal government awards a contract with an average value of \$465,000 (Stanberry, 2001). In fiscal year 2004, federal government procurement spending totaled approximately \$328 billion. Of that amount, approximately \$99 billion was spent by the civilian agencies, with the remaining \$228 billion spent by the Department of Defense (Federal Procurement Data System, 2005). Furthermore, the Department of Defense is the federal government's largest purchaser of services. As illustrated in Figure 18, since FY 1999 DoD's spending on services has increased by 66%, to over \$118 billion in FY 2003, approximately 57% of total procurement value.

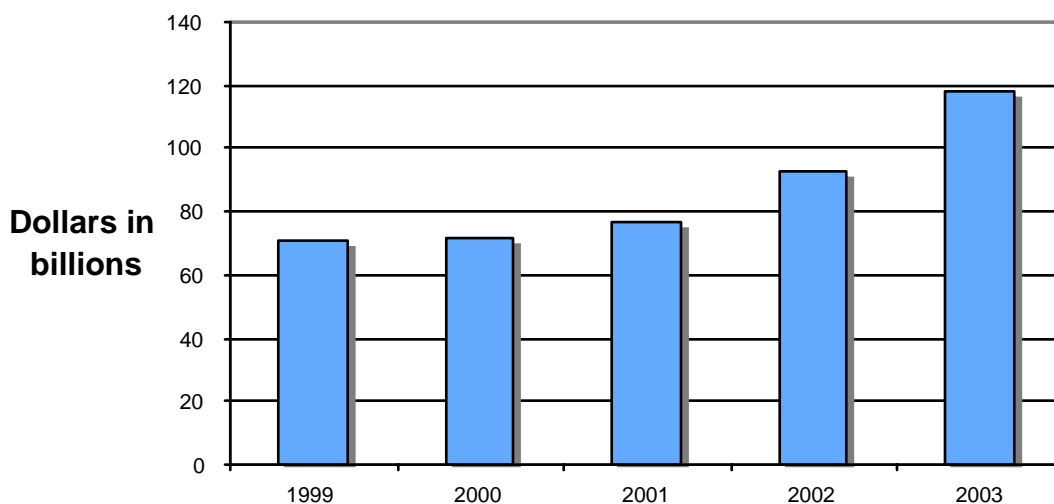


Figure 18. DoD Spending on Services
(GAO-05-274, 2005, March, p. 5)

Compared to other contract categories, the expenditure in services is the largest single spend category in the Federal Government. Figure 19 reflects the growth of services contracts in relation to the other contract categories. Between FY 1990 and 2000, procurement for services grew from \$70 billion to \$87 billion, where the procurement of supplies and equipment decreased from \$102 billion to \$77 billion in that same time frame.

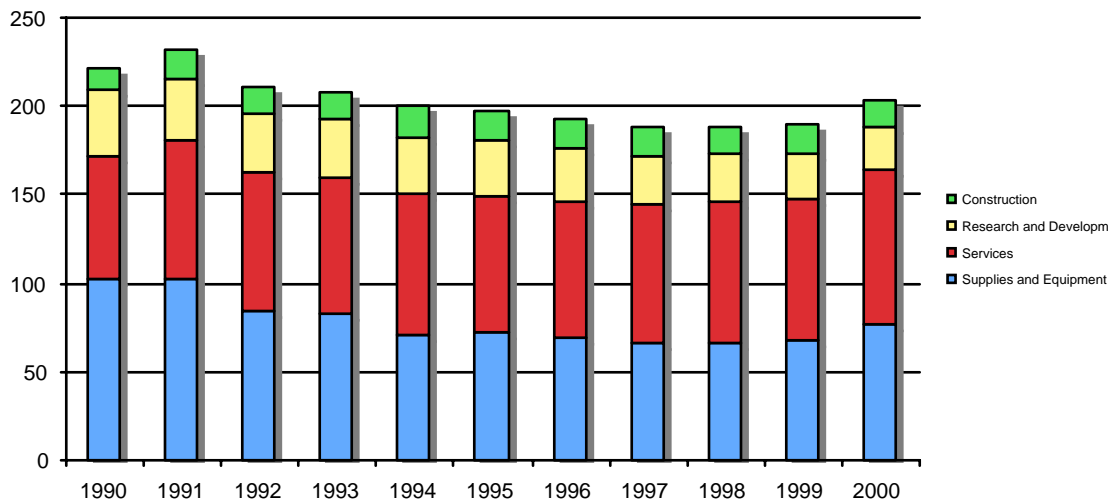


Figure 19. Federal Contract Spending
(GAO 01-753T, 2001, May, p. 3)

Moreover, Figure 20 compares the procurement of services with the procurement of goods during the period between FY 1998 and FY 2002 in the Department of Defense.

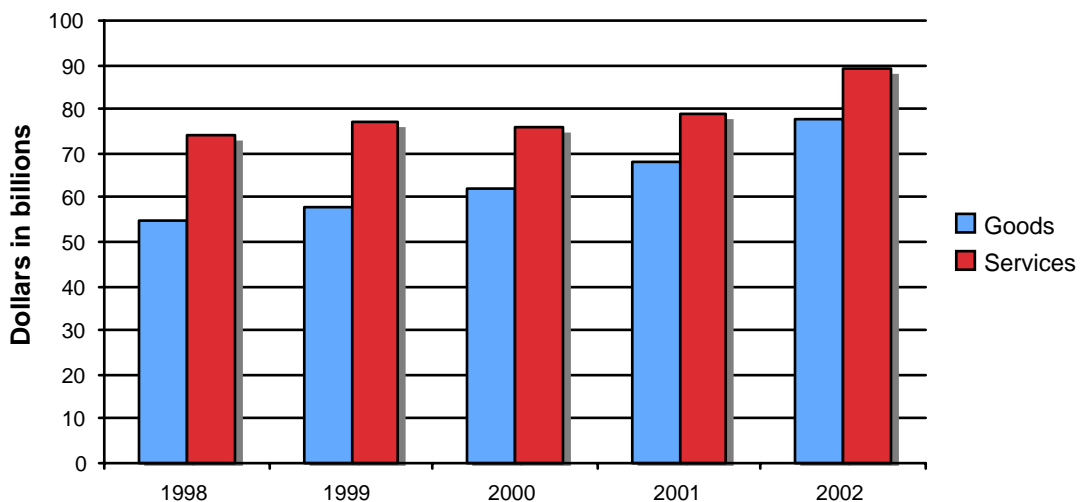


Figure 20. DoD's Contracts for Goods and Services
(GAO 03-935, 2003, September, p. 4)

The DoD procures a variety of services in support of its mission. These services range from traditional commercial contracts such as IT support, custodial services, and grounds maintenance, to mission-related services such as aircraft and engine maintenance and initial pilot training. Figure 21 shows the major categories of services procured by the DoD and their values; here we see that Professional, Administrative, and Management Support, and

Construction, Repair and Maintenance of Structure and Facilities are the types of services most often procured by the Department of Defense.

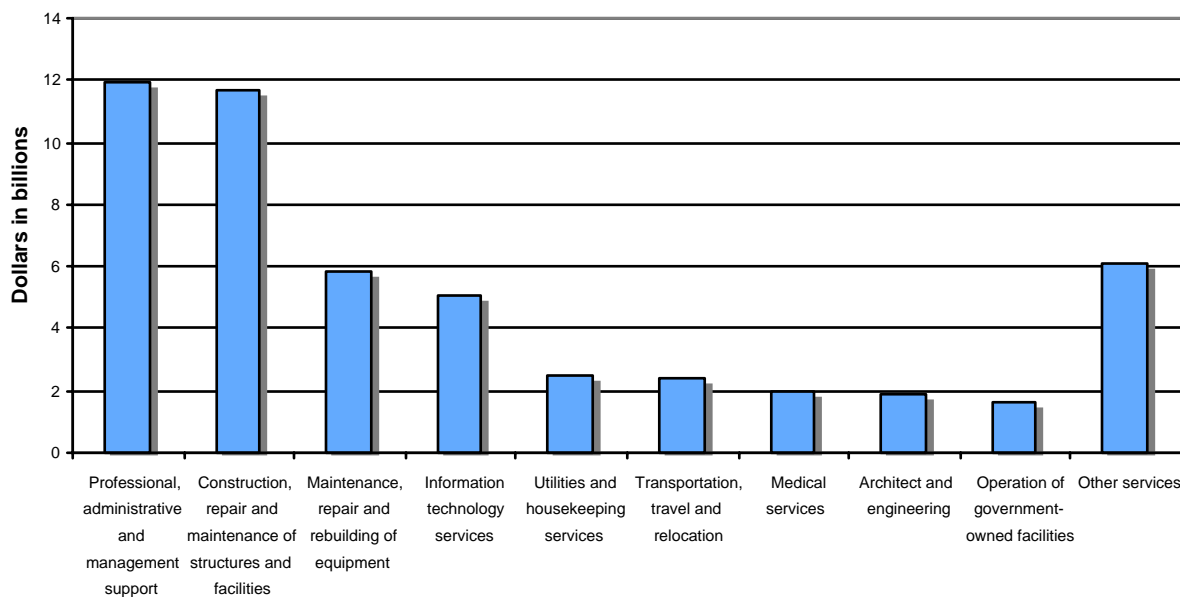


Figure 21: Services Purchased by the DoD in FY 2000
(GAO 02-230, 2002, January, p. 18)

We identified specific examples of these various services during recent visits at military installations in the central and northern California area. For example, at the Presidio of Monterey, an Army installation providing support services to the Defense Language Institute and the Ord Military Community, the Army contracts for base operations support, grounds maintenance, custodial services, and dining facilities services, among other contracts (Auernig, 2006).

At Travis Air Force Base, a major Air Mobility Command (AMC) base, these same types of services are procured, as well as several mission-unique services such as transient alert services for the flight line operations, passenger screening for the airfield passenger terminal, and falconry services in support of the Bird Aircraft Strike Hazard (BASH) program. In addition, Travis AFB also provides contracting support to the David Grant Medical USAF Center. In this capacity, Travis AFB procures various medical services such as medical transcription, nurse services, blood testing, registered nurse staffing, and medical coding services (60th CONS, 2006).

Services Contract Management—An Overview

The management of DoD's services contracts typically follows the traditional contract management process. This contracting process consists of the following phases: procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract closeout as illustrated in Figure 5 (Garrett & Rendon, 2005). Each of these contracting phases will be discussed, along with key practice activities.

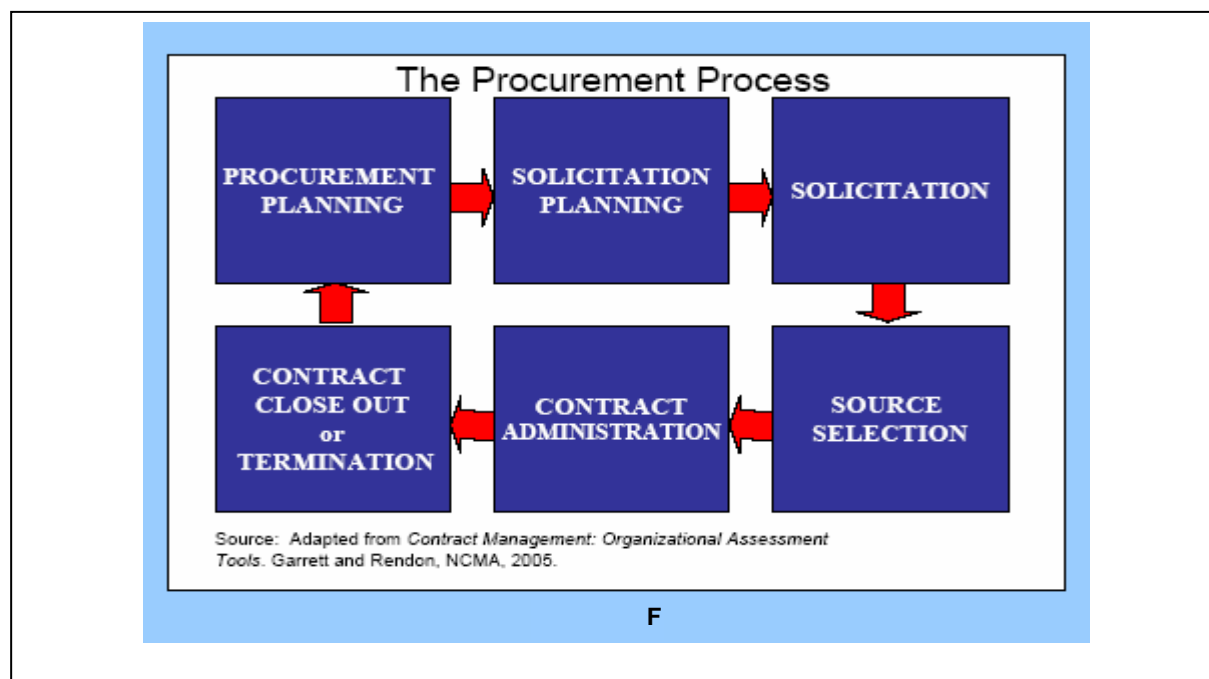


Figure 5, The Procurement Process

Procurement planning is the first contracting phase and involves identifying which business needs can be best met by procuring products or services outside the organization. This process involves determining whether to procure, how to procure, what to procure, how much to procure, and when to procure. Key practice activities included within the procurement planning phase include determining the initial scope of work or the description of the product in the acquisition, conducting market research to analyze the level of technologies and types of products and services available in the marketplace, determining funds availability, and developing initial cost and schedule estimates as well as manpower resources. Developing an initial Statement of Work (SOW) and Work Breakdown Structure (WBS) are also included in the procurement planning phase. Conducting an initial integrated assessment of contract-type selection, risk management, and an initial analysis of potential contract terms and conditions is also part of the procurement planning process (Garrett & Rendon, 2005). It should be noted that many of the contractual documents developed in the procurement planning phase are initial draft documents, such as SOWs, WBSs, project scope statements, and funding and manpower estimates. These are initial draft documents simply because they are typically modified and revised as the acquisition program office becomes more knowledgeable of the business and technical aspects of the program. Industry business and technical knowledge are typically acquired through the use of market research activities, industry conferences, and Requests for Information (RFIs).

The second phase of the procurement process is **solicitation planning**, which involves the process of preparing the solicitation documents needed to support the acquisition. This is a critical phase of the procurement process since it is during this phase that the work statements, specifications and other exhibits, standard terms and conditions, as well as special contract requirements are developed, revised, and finalized. Key practice activities within the solicitation planning process include using standard procurement forms and documents such as solicitation templates, model contracts, specifications and item descriptions, solicitation provisions, and contract terms and conditions (Garrett & Rendon, 2005).

Solicitation is the third phase of the procurement process and is the process of obtaining bids and proposals from prospective sellers on how to meet the objectives of the project. The solicitation phase is critical to the overall acquisition strategy because it is this phase that executes the procurement planning strategy for a full and open competition or sole source procurement. Some key practice activities within the Solicitation phase include conducting market research and advertising to identify new sources of supplies and services for the purpose of developing a list of interested offerors (Garrett & Rendon, 2005). These offerors will receive the solicitation requesting the proposal. Another key practice activity in the Solicitation phase includes conducting a pre-solicitation or pre-proposal conference to ensure that all prospective contractors have a clear, common understanding of the technical and contractual requirements of the acquisition (Garrett & Rendon, 2005).

Source selection is the fourth phase of the contracting process and involves the process of receiving proposals and applying evaluation criteria to select the contractor. Key practice activities within the source-selection process include using evaluation criteria focusing on management, technical, and cost, tailoring the basis for award to either lowest cost/technically acceptable or best value, and taking into consideration an offeror's past performance in evaluating proposals (Garrett & Rendon, 2005).

Contract administration is the fifth phase of the contracting process and entails managing the relationship with the contractor and ensuring that each party's performance meets the contract requirements. During contract administration, the government's focus is on managing the contractor's cost, schedule, and performance. Key practice activities within the contract administration process include using an integrated team approach for monitoring the contractor's cost, schedule, and performance, and having an established process for administering incentive and award-fee provisions (Garrett & Rendon, 2005). These incentives and award fees are tools used to motivate the contractor to meet specific performance standards.

The Federal Acquisition Regulation (FAR) identifies two major contract categories: cost reimbursement contracts and fixed-price contracts, depending on the method of compensation due to the contractor. In the fixed-price category, the contractor agrees to provide specified supplies or services in return for a specified price, either a lump sum or a unit price. The price is fixed and is not subject to change regardless of the contractor's actual cost experience. Only if the contract is modified is the price subject to change (Garrett & Rendon, 2005). There are various types of fixed-priced contracts such as Firm Fixed Price (FFP), Fixed Price with Economic Price Adjustment (FP-EPA), and Fixed Priced Incentive (FPI). In the cost reimbursement contract category, the contractor agrees to provide a best effort in performing the requirements of the contract, which is typically described based on broad specifications. In return, the contractor is reimbursed for all allowable costs up to the amount specified in the contract. Among cost reimbursement contracts we find Cost Sharing (CS), Cost Plus Fixed Fee, (CPFF), Cost Plus Incentive Fee (CPIF), and Cost Plus Award Fee (CPAF).



The final phase of the contracting process is **contract closeout**, the process of verifying that all administrative matters are concluded on a physically complete contract. This involves accepting final deliveries, making final payment to the contractor, as well as completing and settling the contract and resolving any open items. Key practice activities within the contract closeout phase include using checklists and forms for ensuring proper documentation of closed contracts and maintaining a “lessons learned and best practices” database for use in future contracts and projects (Garrett & Rendon, 2005). An important aspect of closing out the contract is conducting a final evaluation of the contractor’s performance in terms of meeting cost, schedule, and performance objectives. This final contractor evaluation will be used in future contract competitions and source selections. The contract closeout phase is often forgotten and has been considered an administrative burden or relegated to a clerical or non-essential task.

DoD Policy on Contracting for Services

Since the beginning of the 1990s, DoD has seen a steady growth in the volume, complexity and value of service contracts. Some of this growth results from an increase in the level of operations, some of it from the replacement of the civilian workforce by contractors, and some is a result of government policy dictating maximum use of contractors.

Compared with other federal agencies, the Department of Defense is often viewed as being particularly aggressive in complying with the Office of Management and Budget’s Circular A-76, Performance of Commercial Activities. The Circular directs that the “longstanding policy of the federal government has been to rely on the private sector for needed commercial activities.” A commercial activity is defined as “a recurring service that could be performed by the private sector and is resourced, performed, and controlled by the [government] agency through performance by government personnel, a contract, or a fee-for-service agreement” (OMB, 2003).

Accompanying this growth in outsourcing activity has been a downsizing of the DoD civilian and military acquisition workforce, which is responsible for administering these contracts. Also, Congress has mandated a shift to Performance-based Service Acquisition (PBSA). PBSA is intended to obtain higher levels of contractor performance at lower cost, and promote a partnership-oriented, long-term approach that allows the government—and the DoD in particular—to benefit from commercial best practices (AFI 63-124, 2005; DODIG, 2003; FAR, 2006).

It is of interest that Circular A-76 mandates that, while actual performance of an activity may be outsourced, control remains with the government agency no matter what decision is ultimately made as a result of a competition between in-house and commercial providers.

The complexity of the monitoring process and the nature of the services outsourced make this contradiction even more difficult to live with. A sanguine, yet now somewhat dated view of agency’s overall management challenges has been provided by the DoD Inspector General:

The seven audit reports that I am bringing to your attention today have a common theme, which is that eleven years of workforce downsizing, without proportionate workload reductions or productivity increases, have created or exacerbated mission performance problems across a wide spectrum of DoD organizations and civilian personnel specialties. In an age when organizational agility is the watchword for successful businesses, DoD has been anything but agile, when it comes to managing



human capital. This is partially due to restrictive personnel management laws and regulations, but also to previous reluctance to innovate and lack of strategic planning regarding the civilian workforce. (DODIG, 2001)

In transaction cost analysis (Williamson, 1983), a distinction is made between the cost of delivering the service (“production” costs) and the cost of managing the relationship between the buyer and seller (“transaction” costs). Circular A-76 directs a decision based entirely on production costs, while remaining silent on transaction costs. Yet, from the point of view of both the taxpayer and the mission, the total cost should perhaps be the deciding factor.

The issue of “control” (also referred as a synonym to “oversight” or “surveillance”) transcends that of cost. The government agency that has outsourced the activity may simply not have access to the necessary personnel or budget to adequately exercise this control. Williamson emphasizes that, traditionally, a hierarchical (in-house) arrangement has lower transaction costs because it is easier to direct one’s own employee to perform an activity. In contrast, specialist firms may have lower production costs because of experience or some type of economies of scale. The challenge for government is to equitably consider all these factors when making a sourcing decision.

The Challenge of Outsourcing Services

Traditionally, DoD contracting practice has been focused on goods, not services. This is in spite of the fact that services now account to over 55 percent of the dollar volume of DoD contracts (DODIG, 2005). A similar trend has been observed in other federal agencies (GAO, 2005e). Congress has mandated, through the National Defense Authorization Act of 2002, an improved management of the service contracting process (GAO, 2005b).

Outsourcing services on a large scale poses unique challenges for the DoD. The department’s employees, both those officially part of the “acquisition workforce” and those otherwise involved in the services acquisition process, are the focal point of any effort to increase the quantity and quality of outsourcing. Yet at the same time, the numbers of those employees have been falling rapidly; it is not unreasonable to claim that, in many cases, the necessary numbers of staff or skills are not present to ensure the adequate monitoring of the increased scale.

DoD has a responsibility to act as a “knowledgeable client” for the nation in its relationship with the private sector. As a knowledgeable client, its employees must be in a position to maintain a number of capabilities, including the following:

1. An understanding of what services may or should be outsourced;
2. An awareness of the capabilities and limitations of private sector firms in the appropriate area;
3. The ability to tender for and competently evaluate competing bids from both private sector firms;
4. Where a service currently provided in-house is being considered for outsourcing, the ability to evaluate competing bids from in-house and private sources according to the complex requirements set by the Office of Management and Budget;



5. The ongoing ability to develop, maintain, and improve the surveillance of contracted activity to ensure that value is being obtained, and to take corrective action where required (OMB, 2003; GAO, 2005b).

All of the above require an appropriate number of skilled personnel in a wide variety of fields. Expertise is needed in both contracting per se and in the technical or functional area that is being outsourced. Where outsourcing is viewed as a way to reduce government headcount (particularly that of civilian personnel), those remaining in the job need to have higher level of expertise to carry out adequate surveillance of contracted activity. The GAO has emphasized the importance of improvements in monitoring (or “surveillance”) of DoD service contracts:

According to DoD officials, insufficient surveillance occurred because surveillance is not as important to contracting officials as awarding contracts and therefore, does not receive the priority needed to ensure that surveillance occurs. [...] Further, surveillance was usually a part-time responsibility and some personnel felt that they did not have enough time in a normal workday to perform their surveillance duties. (GAO, 2005b)

Addressing human capital issues in acquisition is not just a matter of the size of the workforce. It is also a capacity issue. While acquisition reforms have helped streamline smaller acquisitions, larger acquisitions, particularly for information technology, remain complex and technical. Yet agencies are at risk of not having enough of the right people with the right skills to manage these procurements. Consequently, a critical issue the federal government faces is whether it has today, or will have tomorrow, the ability to manage the procurement of increasingly sophisticated services. (GAO, 2001b)

That such phenomena should occur is perhaps a natural outcome of the contradictory forces at work in outsourcing activities. While the emphasis is on reducing in-house personnel, outsourcing in itself may require a targeted increase in the number of government employees, as well as some change in their qualifications, to ensure that outsourcing is carried out according to regulations in a cost-effective, “best value” manner.

The Air Force represents an example of an effective approach to the need for up-front planning of the in-house personnel requirements associated with outsourcing, as well as the inherently interdisciplinary mix of government personnel need for adequate contract surveillance (AFI 63-124, 2005). However, the Air Force experience illustrates the difficulties of considering potential or actual contract management costs as part of the outsourcing decision.

A RAND study of 22 PBSA-inspired contracts at 15 Air Force bases concluded that information on the internal costs of outsourcing was “highly impressionistic” and that data on quality assurance costs, which should theoretically decline with a switch to PBSA, were ambiguous (Ausink, Camm, & Cannon, 2001). Even the actual expenditures on contracts were difficult to calculate and evaluate within the agency:

DoD is in the early stages of a spend analysis pilot. Although DoD is moving in the right direction, it has not yet adopted best practices to the same extent as the companies we studied. Whether DoD can adopt these practices depends on its ability to make long-term changes necessary to implement a more strategic approach to contracting. DoD also cites a number of challenges, such as its large and complex need for a range of services, the fragmentation of spending data across multiple information systems, and contracting goals for small businesses that may constrain its ability to consolidate smaller requirements into larger contracts. Challenges such as these are difficult and deep-rooted, but companies also faced them. For DoD to change management practices



for the contracting of services will require sustained executive leadership at DoD as well as the involvement and support of Congress. (GAO, 2003a)

Given the difficulties of capturing costs at many levels and for different activities, it is perhaps not surprising that the DoD also suffers from major challenges in personnel management.

The “Human Capital” Issue

It is somewhat ironic, but not at all unexpected, that the downsizing of the DoD civilian workforce, and the increasing emphasis on moving military personnel into deployable positions, has resulted in increased concerns about who is minding the store. In its government-wide review of the acquisition function, the GAO emphasizes “human capital” as a “cornerstone” for an effective acquisition function, in particular, “Valuing and Investing in the Acquisition Workforce.” Also, “Integration and Alignment” should form part of “Strategic Human Capital Planning” (GAO, 2005e)

The emphasis on “Integration and Alignment” is particularly salient for the DoD. What is being implied is that the in-house workforce needs to be developed and maintained in a manner commensurate with the workload requirements created by outsourcing. In an analysis of the Air Force’s PBSA activities based on commercial practices for outsourcing of installation management, RAND noted that government personnel should have the ability to:

- describe what service is desired and not how to perform the work;
- use measurable performance standards and quality assurance plans;
- specify procedures for reductions in fee or price when services do not meet contract requirements, and
- include performance incentives where appropriate. (Baldwin & Hunter, 2004)

Yet Baldwin and Hunter also emphasize in the same report the need for more sophisticated statements of requirement, refinement and reduction of performance metrics, and, notably, widespread participation in the services contracting process. Such participation necessarily requires time and the application of expertise by qualified people. Particularly in an era of downsizing and with an aging workforce, recruiting and retaining suitable civil service personnel is a difficult process. Meanwhile, the military services must “grow their own” personnel in a closed environment (that usually begins at the recruiting station) and balance a complex mix of occupational specialties, ranks, and attrition rates with the added complication of deployments that are impossible to forecast.

The FAR and other contracting regulations impose a host of responsibilities, such as those discussed above, on acquisition and other government personnel for the entire services contracting lifecycle. Not only must the agency head ensure that these responsibilities are carried out, but “best practices” must be used (FAR, 2006, Subpart 37.501). However, the policy-making agencies responsible for contracting rules have little connection to the organizations who set budgets or who assign qualified people to the positions required to develop or monitor the contracts that result from those contracting rules.

In the private sector, this lack of communication may be less of a barrier, given the common sense of purpose imposed by the pursuit of profit (Baldwin & Hunter, 2004). However,



it is reasonable to state that increased contracting and decreased surveillance could lead to reduced quality performance. Some of the more extreme examples of this divergence in direction that have already led to widespread media attention include insufficient monitoring of contracts in Iraq by the DoD, the Department of State, and other federal agencies (GAO, 2006) and the employment of illegal immigrants by contractors at military installations (Witte, 2005).

The Department of Defense has responded to some of this divergence in policy by attempting to supplement or substitute on-site human expertise using a variety of methods. The first is to centralize, either on a national or regional basis, expertise in contracting or in a functional area, taking some responsibilities (and positions) away from individual installations. For example, the Army Contracting Agency and Army Installations Agency have been established as “centers of excellence” to direct and assist with the provision of the appropriate services.

The Department of the Navy has placed all shore-installation management activities under regional commanders (such as Commander Naval Region Southwest) who then may establish detachments, as tenant activities, at specific installations as the perceived need may justify. Contracting itself has also been centralized in the Navy; for example, all contracts above the “simplified acquisition threshold” (usually meaning small purchases such as office supplies which are carried out locally using credit cards) are done by the Fleet and Industrial Supply Center (FISC) for that region. For example, the FISC in San Diego serves all Navy and Marine Corps installations in California and Nevada.

Another method used by the DoD is to “virtualize” expertise by creating Web-based sites where published direction, documents such as “lessons learned” can be posted, or chat rooms can be hosted. There are now a variety of such facilities in place. While these initiatives may appear laudable, questions remain. Centralization and regionalization are convenient vehicles for budget cuts, with the side-effect of removing financial management flexibility from installation commanders. The authors did note, however, that the Air Force seems to be resisting this trend and that Wing Commanders at installations are retaining a traditionally broad range of responsibilities, personnel and budget under their chain of command.

Notice that many types of services, and their contracts, do not lend themselves to codification or to asynchronous communication. In such circumstances, the richness of face-to-face communication and the leveraging of experience acquired by long-serving government personnel can be diminished or lost if human capital is not carefully managed. According to Nonaka and Takeuchi (1995),

frequent dialogue and communication helps create a “common cognitive ground” among employees and, thus, facilitates the transfer of tacit knowledge. Since members of the organization share overlapping information, they can sense what others are struggling to articulate.

The shift from explicit, clerical-like functions to complex activities requiring a much more significant component of judgment is well represented by two shifts: one being that the majority of DoD acquisition is now in services rather than goods, and the second being the emphasis on PBSA. For example, the Air Force established a goal that at least half of all service acquisitions should be performance-based by 2005 (Baldwin & Hunter, 2004). Rendon (2005) has also commented that what was previously viewed simply as “purchasing” within the DoD has now evolved into a complex process that includes integrated supplier management, consideration of total ownership costs, cross-functional teams, and strategic sourcing strategies.



Yet a RAND study of the Army showed that the remaining civilian acquisition personnel were not being used “as effectively as they should be,” even with the recent loss of many military acquisition personnel to deployments (Hanks et al, 2005). The shift toward PBSA has significant implications for the government’s in-house capabilities to perform outsourcing, but how these implications will be dealt remains an interesting area for further research.

In its comprehensive review of the federal government’s outsourcing process, the Commercial Activities Panel a congressionally-chartered body chaired by the head of the GAO, emphasized that outsourcing policy be “consistent with human capital practices designed to attract, motivate, retain, and reward a high performing federal workforce.” Similarly, the Panel concluded that “the government faces continued and significant management, human resource, and professional development challenges, which affect the government’s ability to manage the cost, schedule, and performance of in-house and contracted activities” (GAO, 2002b). A significant increase in the volume, cost and complexity of outsourced activity, declining numbers of experienced personnel, increased deployments, and widely rumored budget cuts do not point to a simple resolution of the challenges of contracting for services within the DoD.

It is difficult in the best of times to undertake horizontal coordination between or within different agencies in Washington and translate them into improved cost-effectiveness in the field. Yet, the integration of strategic human planning with other functions has been identified as critical to achieving desired mission outcomes (GAO, 2005a; GAO, 2005c). The DoD must also remain an attractive customer for the best-performing businesses, and remain a “knowledgeable client” so it can continue to act as an effective steward of public funds. PBSA, in the words of a RAND study, requires the DoD develop a “better understanding of how commercial firms do things” (Ausink, Camm, & Cannon, 2001). Given the emerging environment, maintaining an effective capability within DoD to determine if and how services should be delivered, and how such services should be overseen, may pose a significant challenge.

Site visits

As part of this research, we visited two bases to collect information about their respective service acquisition processes: the Presidio of Monterey (POM) and Travis Air Force Base. We visited their facilities, interviewed their contracting officers and spoke with several among their contract customers. Our impressions follow.

Presidio of Monterey

The Presidio of Monterey has a complex history. Originally established as a fort (the Spanish meaning of “presidio”) under Spanish rule in 1770, POM began its life under the US flag as a garrison for Marines in 1846. The site was inactive from 1856 until 1902, and hosted a variety of Army units until its official closure in 1944. Military training in the Monterey area continued five miles north of the city at Fort Ord (established 1917), at 28,000 acres one of the largest Army bases ever established. Fort Ord operated as a basic and advanced combat training center and until its closure under the Base Realignment and Closure (BRAC) process in 1994. After 1994, the POM continued to operate on its original 392 acres, which currently includes 180 buildings (Uslar, 2006). While language training in Japanese began in secrecy at the dormant POM beginning a few months before the attack on Pearl Harbor, in 1946, the site was officially reactivated as a foreign language training center, now known as the Defense Language Institute Foreign Language Center (DLIFLC or informally DLI). While DLI is part of



the Army's Training and Doctrine Command (TRADOC), it has always had the mission of training military personnel from all of the military services. Additionally, a small number of civil servants from DoD and other federal agencies learn foreign languages at DLI, which graduates over 3,000 students annually in about 25 languages. While TRADOC is responsible for the funding and management of DLI, the functional sponsor is the Office of the Secretary of Defense (OSD).

When Fort Ord closed in 1994, the Army began transferring segments of the base to a variety of entities. A small portion of Fort Ord was retained for military use and designated as Ord Military Community (OMC). OMC includes DoD offices, housing, community facilities, and notably some POM and DLI organizations that could no longer be accommodated on the original POM site, given the growth of DLI. Some support, such as transportation and recreation, is also provided by POM to other DoD installations in the Monterey area. In a reversal of roles since the 1994 BRAC action, OMC is now a "tenant activity" of POM, which provides all administrative support such as contracting. (DLIFLC, 2006a; DTSC, 2006; POM 2006).

Since the closure of Fort Ord, the end of the Cold War and the attacks of September 11, 2001, DLI has both changed its mission and begun to grow rapidly. The focus has changed from the languages of the Warsaw Pact to those of the Middle East and Asia. In January 2006, DLI received additional funding of \$362 million from OSD to further enhance the quantity and quality and instruction of over 200 classrooms and offices. This includes reducing average class size, hiring over 300 additional language instructors above the current complement of approximately 900, as well as adding about 250 additional support staff. A great deal of construction is also planned extending until approximately 2012. POM, whose physical facilities have developed in the haphazard manner so typical of military bases, will evolve into a more campus-like facility designed around DLI's mission. Given the current expansion of POM and DLIFLC activity levels, a key challenge for both organizations will be agreeing on common levels of support and coordinating mission expansion and physical space requirements (Cairns, 2005; Howe, 2006).

Contracting Organization

Contracting for DLI and other activities supported by POM is provided by the Directorate of Contracting (DC), which falls under the POM Garrison Commander. Previously located on the POM proper, the DC's offices relocated in early 2006 to the DoD Center, a large building at OMC, which was served as the medical center for the previous Fort Ord. The DC is also functionally part of the Army Contracting Agency Southern Region (ACASR), headquartered at Fort Sam Houston in San Antonio, Texas. DLI is the largest single entity supported by the DC; its needs tend to directly or indirectly influence the remainder of the contracting activity carried out by the DC.

Furthermore, although DLI is the responsibility of TRADOC, POM and its associated physical infrastructure (land, roads, buildings, and utilities) is the responsibility of the Army's Installation Management Agency (IMA) Southwest Region, also headquartered at Fort Sam Houston. POM is also responsible for management of two training facilities: Fort Hunter Liggett and Camp Roberts, both located about 80 miles southeast of Monterey near Paso Robles.

Accordingly, the DC has a number of reporting relationships within the DoD, in addition to dealing with private bidders and contractors. Each of these relationships encompasses a specific mission, budgetary allocation, and regulatory framework. Additionally, the funding and activity levels may not necessarily be coordinated. The GAO has commented that among the



services, the Army appears to have the greatest problem maintaining adequate levels of Base Operating Support (BOS) funding, which can potentially contribute “to the degradation of many installation facilities and can adversely affect the quality of life and morale of military personnel” (GAO, 2005d).

The above situation represents a challenge where the base’s mission (in this case, particularly language training) is growing rapidly but, for example, the IMA or ACA is not in a position to fund the additional contracting workload associated with that growth. We discussed the challenges imposed by centralization of functional responsibilities within the different services previously. In the case of POM, the GAO’s views on the subject may be particularly pertinent:

Because the military services have often based future requirements estimates largely on prior expenditures, they do not necessarily know if BOS services were provided at appropriate levels. DoD and the military services have a strategic plan for installations and have multiple actions under way to address these problems, but they have not synchronized varying time frames for accomplishing related tasks. Until these problems are resolved, DoD will not have the management and oversight framework in place for identifying total BOS requirements, providing Congress with a clear basis for making funding decisions, and ensuring adequate delivery of services.

While the Army’s and Navy’s creation of centralized installation management agencies can potentially create efficiencies and improve the management of the facilities through streamlining and consolidation, implementation of these plans has so far met with mixed results in quality and level of support provided to activities and installations. Until more experience yields perspective on their efforts to address the issues identified in this report, GAO is not in a position to determine whether the approach should be adopted by the other services. (GAO, 2005d)

One unique characteristic of the DC is its relationship with the two nearby cities of Monterey and Seaside. It should be added that the legislation providing for the closure of Fort Ord in 1994 provided for a “demonstration project” (made permanent in 2003) that gave privileged contractor status, on a no-fee cost reimbursement basis, to the Presidio Municipal Services Agency (PMSA) [originally known as the Joint Powers Authority (JPA)]. The PMSA is an inter-municipal consortium of the cities of Monterey and Seaside. The first JPA contract was signed in 1997, and the current agreement under the PMSA has been described as follows:

Under the expanded contract, which was signed in May 1999, the JPA maintains about 120 buildings at DLIFLC & POM and 35 buildings at the Annex. The buildings include such facilities as shopping malls, churches, a movie theatre, libraries, barracks, clubs, a sports center, and administrative buildings. As part of the contract, the building maintenance crews from the City of Monterey operate from facilities and shops at DLIFLC & POM, ensuring that support and services is immediately available.

Competing against national, commercial businesses, the City of Monterey was again awarded the contract through a competitive bid process in 2001. The contract is priced at \$18 million over a 5-year period. Fire services are now contracted separately (see section above on Fire Protection Services at POM) and sewer maintenance is no longer part of the contract, as the City purchased the sewer system in July 2002.



Through this partnership and contract, the Army has realized a 41% reduction in expenses when compared with previous base operation costs and private contracts. The City has also worked with the military staff to reduce energy costs, by installing photocell timers and HVAC controllers. Some \$60,000 in energy costs alone have been saved annually for one building. (DLIFLC, 2006b)

In 2000, the Army Audit Agency concluded that the use of PMSA had resulted in a 41% cost reduction compared to previous military and private services providers. POM has explained that “the local municipalities have built-in incentives to reduce costs, improve techniques, and streamline procedures as they are using their resources up front until they are reimbursed” and that Monterey and Seaside are “non-profit agencies with reasonable general and administrative costs” with the necessary technical expertise in areas such as traffic engineering (POM, 2004).

During the 2005 BRAC hearings, the “Monterey model” was cited as an example of a technique for reducing BOS costs, and a number of adjoining communities proposed similar arrangements could be put in place to preserve their military installations. It is of interest that the PMSA uses the services of both cities’ municipal workforces and also contracts with the private sector to carry out work on the POM and OMC sites. Routine maintenance carried out by PMSA for the Army currently costs approximately \$5.3 million in fiscal year 2004-2005 (Cairns, 2005). The service supply-chain model of the contracting arrangements at POM is shown in Figure 6.

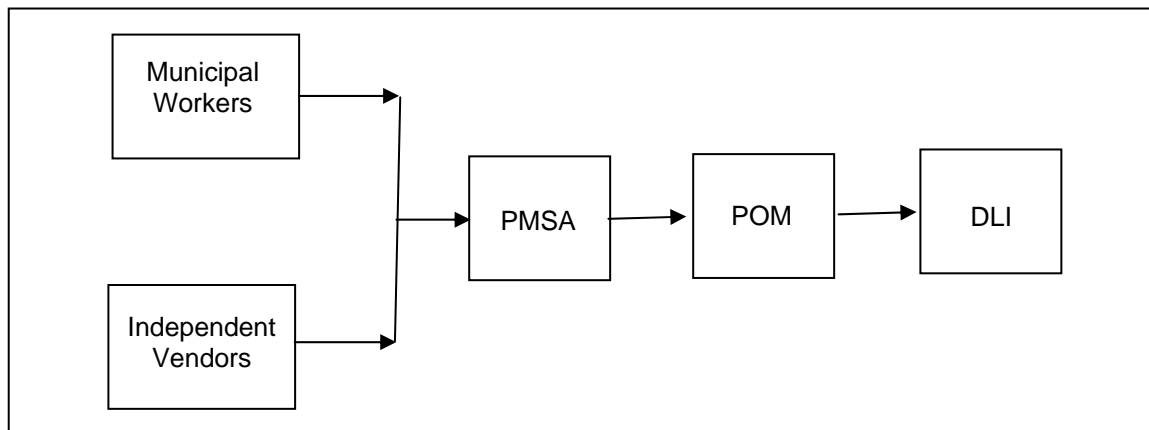


Figure 6. Service Supply Chain at POM

Contracting Activities

The DC is responsible for managing 53 contracts involving approximately 500 contracting actions (such as new contracts, renewals and amendments) annually, representing a total value of approximately \$35 million, including \$5.3 million contracted with PMSA (Cairns, 2005). However, as described above, the creation of IMA and ACA have had a significant impact on the DC’s staff, which has declined from 80 to 12. Additionally, funding is often inadequate to cover contracts in force, and often is allocated by IMA or ACA on an incremental (less than yearly) basis.

Major contracts managed by the DC during FY2006 included grounds and other infrastructure maintenance (mainly through the PMSA), supply of gas and electricity, custodial

(janitorial) services, food services (which use contractor personnel in two POM dining halls), maintenance and dispatching of the motor pool (including buses), audio visual and IT services in support of the instructional mission, and fire protection for the POM from the City of Monterey, which is not covered by the PMSA.

For each contract, monitoring of contractor performance is the responsibility of the POM, DLI or other organization that benefits from the contractor's services. For example, custodial services are monitored and the contractor performance reported to the DC by government employees within the Directorate of Public Works. These personnel are known by various titles such as "technical personnel" or "quality assurance evaluators."

Efforts are underway to improve and standardize the training of these staff members so that they can carry out their duties in a consistent manner and ensure that the DC has the proper information on contractor performance in exercising its oversight responsibilities on behalf of the government. These initiatives are particularly important given the shortage of contracting staff. A related initiative by the DC to deal with the staffing problem is to reduce the total number of contracts through consolidation, which has a major impact on the administrative workload of both DC and user organization personnel.

We found POM staff to be highly conscious of their role in supporting the mission, notably DLI's rapidly expanding instructional activities. However, there is concern about the long-term ability of POM to provide an acceptable level of service to DLI given the significant staff reduction. The problems can be deceptively subtle. For example, we mentioned previously that DLI has received significant funding from OSD to improve the quality of instruction and the production of qualified linguists. However, much of the supporting infrastructure for this initiative will be provided through contracts. Requirements determination, market research, tendering, evaluation of proposals, correspondence with bidders, bid evaluation, contract award, and contract monitoring all require a variety of qualified personnel who may not currently be available. Additionally, agencies such as IMA, ACA or TRADOC may view DLI's expansion as an OSD-directed initiative that does not necessarily commit those organizations to assisting POM.

Travis Air Force Base

Travis Air Force Base is located approximately 50 miles northeast of San Francisco. Travis can be considered a small city unto itself, complete with airport, hospital, restaurants, and neighborhoods. As an Air Mobility Command (AMC) Base, Travis is home to the 60th Air Mobility Wing (AMW), which is the largest air mobility organization in the Air Force. Flying the Lockheed C-5 Galaxy cargo aircraft and the KC-10 Extender tanker aircraft, the 60th AMW fulfills its mission of Global Reach and flying support and humanitarian airlift missions anywhere in the world. Travis is also home to the David Grant Medical Center, the second largest medical treatment facility in the Air Force.

Contracting Support

Providing contracting support to Travis Air Force Base is the mission of the 60th Contract Squadron (CONS). The 60th CONS awards and administers over \$320 million annually in contracts for construction, supplies, and services (60th CONS mission overview, 2006).



In terms of services contracts, the 60th CONS manages service contracts that are traditionally found at most Air Force bases. These services include grounds maintenance, food services, custodial, and military family housing maintenance. Due to the unique mobility mission of Travis AFB and the medical mission of the adjacent David Grant Medical Center, the contracting squadron also manages some specialized services contracts such as passenger terminal screening, professional medical staffing services, and falconry services.

Services Contracts

Travis AFB contracts with Pride Industries for many labor-intensive service contracts such as grounds maintenance, food services, custodial, and military family housing maintenance. Pride Industries is also the contractor for the passenger terminal operations and pre-board screening. It is “the nation's largest employer of people with disabilities and provides a variety of outsourcing solutions to meet the manufacturing and service needs of companies nationwide” (Pride Industries). These contracts are based on a Firm Fixed Price (FFP) basis and use predominantly detailed specifications. Contracts based on detailed specifications are focused on the contractor complying with specific government requirements specified in the Statement of Work (SOW).

In supporting the David Grant Medical Center, Travis uses performance-based service contracts for nursing personnel supply, intensive care unit (ICU) services, natal services, and pediatric care. Performance-based service contracts are designed to focus on the desirable performance results, including specific measurable objectives, and quality assurance plan to ensure that contract requirements are met or exceeded (Garrett & Rendon, 2005). Performance-based service contracts are based on a Statement of Objectives (SOO) developed by the government, included in the government’s solicitation or Request for Proposal (RFP). The SOO identifies the end-results or desired performance results of the contract.

Organizational Processes and Tools

The 60th Contracting Squadron interfaces with the base organizations that own or manage the required service. For example, the 60th Civil Engineering Squadron owns the requirement for the grounds maintenance, custodial, and military family housing maintenance services. The Services Squadron owns the requirement for the food services, and the Medical Center owns the requirement for the medical services. These requirement owners represent the users for these specific services and, thus, are responsible for developing the Statement of Objective (SOO) or Performance Work Statement (PWS), Quality Assurance Surveillance Plan (QASP), and for the actual surveillance of the contractor’s performance.

As the organization providing contracts support the requirement owners, the Contracting Squadron meets periodically with the functional managers and QAEs of those organizations to discuss any critical issues that may result in modifications to the contract Statement of Work, or Quality Assurance Surveillance Plan. Proactive and frequent communications are essential for a successful services contract. Travis AFB uses Business Requirement Advisory Groups (BRAGs) as the mechanism for conducting these communications. BRAGs are teams made up of cross-functional personnel that represent the functional organizations involved in the services contracts. These cross-functional teams plan and manage the service contracts throughout the services’ lifecycle, including the market research, requirements determination, procurement planning and solicitation planning, as well as determining the performance surveillance strategy for the contract.



Each requirement organization provides Quality Assurance Evaluators (QAEs) for controlling and managing the contractor's performance. The QAEs are considered functional experts within their specific function (grounds maintenance, custodial, housing maintenance, food services, medical services, etc.) and are responsible for ensuring the contractor meets the requirement of the contract. The Contracting Squadron provides training to the QAEs and manages the base-wide Quality Assurance program. The contractor uses the Performance Work Statement to ensure that it meets the performance objectives of the respective Statement of Objective. The Quality Assurance Surveillance Plan provides the Quality Assurance Evaluator with an effective tool for surveying the contractor's performance. These surveillance tools include random sampling, 100 percent inspection, and periodic surveillance (Rendon, 2001). The QASP is used to ensure that the government receives acceptable contractor performance as compared against the technical requirements of the contract.

Preliminary Observations and Conclusions

We want to underscore that this is an ongoing research project with several activities such as additional base visits and interviews of contracting personnel and customers yet to be completed. Hence, the observations and conclusions herein are preliminary and tentative, and should be viewed as such.

1. The Department of Defense's services acquisition volume has continued to increase in scope and dollars in the past decade. GAO found that since FY 1999, DoD's spending on services has increased by 66%, and in FY 2003, the DoD spent over \$118 billion or approximately 57% of total DoD's procurement dollars on services (GAO, 2005b). DoD procures a variety of services, including both the traditional commercial service and services unique to defense. In terms of amount spent, four service categories represent over 50% of total spending on services: (a) professional, administrative, and management support services, (b) construction, repair and maintenance of structure and facilities, (c) equipment maintenance, and (d) information technology services.
2. Presidio of Monterey (POM) has contracted maintenance of about 155 buildings and structures to Presidio Municipal Services Agency (PMSA), a consortium of the cities of Monterey and Seaside. The PMSA agreement has allowed the two cities to apply their expertise to routine municipal services, and the Army to focus on its military mission. Through this partnership and contract with PMSA, the POM has realized a 41% reduction in expenses when compared with previous base-operation costs and private contracts. We recommend that DoD explore and evaluate the possibility of establishing such synergistic contractual relations with cities adjacent to other bases in supporting of their respective operations.
3. Proactive and frequent communications are essential for a successful services contract. We found a successful example of this at Travis AFB, where 60th CONS uses BRAGs as the mechanism for conducting such communications. Business Requirement Advisory Groups (BRAGs) are teams made up of cross-functional personnel that represent the functional organizations involved as customers in the services contracts. These cross-functional teams plan and manage the service contracts throughout the services' lifecycle.
4. Our visits and interviews at Travis AFB, where the 60th Contract Squadron (CONS) is co-located with the 60th Air Mobility Wing (AMW), and at POM and NAS WI confirmed GAO's finding that "while the Army's and Navy's creation of centralized installation



management agencies can potentially create efficiencies and improve the management of the facilities through streamlining and consolidation, implementation of these plans has so far met with mixed results in quality and level of support provided to activities and installations” (GAO, 2005d).

5. Given the unique characteristics of services, such as intangibility, co-production, diversity and complexity, establishing service specifications, and measuring and monitoring the quality of delivered service is inherently more complex than that in manufactured goods. Hence, it is critical to have on board a “knowledgeable client” and the necessary number of skilled contracting personnel to define the requirements and to supervise outsourced services. The DoD has been aggressively complying with OMB’s Circular A-76, which directs all federal government agencies “to rely on the private sector for needed commercial activities.” This has resulted in dramatic growth in DoD’s spending while downsizing the DoD civilian and military acquisition workforce. Although this exploratory study is not yet completed, we believe that the above two trends contradict the critical need to have on-board a necessary number of skilled contracting personnel. This could mean that in DoD’s outsourced services either the needs are not being fully satisfied, or the value for the money spent is not being realized.
6. Although the DoD acquires more services than goods, and the acquisition of services and the use of service contractors are becoming an increasingly critical aspect of the DoD mission, the management infrastructure for the acquisition of services is less developed than for the acquisition of products and systems. There is a less formal program management approach and lifecycle methodology for the acquisition of services, which is confirmed by the lack of standardization in the business practices associated with the services acquisition process. This results from the fact that the functional personnel currently managing the services programs are not considered members of the DoD acquisition workforce, and are typically not provided acquisition training under Defense Acquisition Workforce Improvement Act (DAWIA) requirements.

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What Works Best when Contracting for Services? An Empirical Analysis of Contracting Performance

Presenter: Sergio Fernandez, Indiana University

Abstract

The practice of contracting for services has become widespread in the United States. Hundreds of billions of dollars are contracted out every year by governments in this country, and innumerable policies and programs are implemented, at least in part, through contractual arrangements between public agencies and private service providers. The situation calls for research to identify factors public managers can manipulate to achieve high levels of performance in contracting for services. Although researchers have produced a large body of work on contracting out, the literature is elusive when it comes to identifying factors that account for success. First, the development of competing theoretical perspectives, each with its own set of propositions about the determinants of performance, confuses practitioners seeking best practices. In addition, most of the empirical research on contracting outcomes has focused narrowly on efficiency or quality of service, while neglecting other important outcomes such as responsiveness to the government's requirements, legal compliance, and customer satisfaction. Finally, nearly all of the studies on contract management and performance have been descriptive in nature and have focused on a very small number of observations. In short, there have been no systematic efforts to validate the various prescriptions for contracting out effectively.

This paper takes on the challenge by developing a comprehensive model of contracting performance. The model is tested using Substantively Weighted Analytic Technique (SWAT), a new methodology that allows researchers to isolate high performance among a large number of observations to identify factors practitioners can manipulate to improve practice. A representative sample of 460 contractual relationships between local governments and private service providers is used in the analysis. Contrary to the prevailing norms about effective contract management, the results indicate that factors such as competition, contract specificity, and contract monitoring fail to account for high levels of performance. Instead, it appears that factors that facilitate adaptive decision making, problem solving and learning—including trust, a willingness to work together to identify and solve problems, and frequent communication—are the ones public managers should manipulate to improve the practice of contracting for services.

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Performance Based Service Acquisition: A Quantitative Evaluation of Implementation Goals and Performance in the United States Air Force

Presenter: Lt Col Curtis G. Tenney, USAF

Capt Dylan D. Pope, USAF

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Abstract

Over the last 12 years, the percentage of the Department of Defense (DoD) budget spent on the procurement of services has risen constantly (Gansler, 2001). In an attempt to maximize cost savings in the rapidly growing services sector, the DoD established a Performance Based Service Acquisition (PBSA) strategy that focuses on evaluating contractor performance based on their ability to meet desired outcomes rather than the means to which the outcomes are obtained. In April 2000, Dr. Gansler, then Under Secretary of Defense for Acquisition, Technology and Logistics, issued a memorandum mandating that 50 percent of all eligible service acquisitions be awarded using PBSA methods by Fiscal Year (FY) 2005. While some studies (Ausnik, Camm, & Cannon, 2001; Ausnik, Baldwin, Hunter, & Shirley, 2002) have attempted to measure the potential increases in quality and cost savings, very little research has been focused on USAF implementation of PBSA and the progress and attainment of the PBSA goals.

Using multiple years of comprehensive data obtained from the Air Force Contract Reporting System, also known as the J001, this thesis extends on previous PBSA research (Lacey, 2004) and seeks to evaluate and analyze the current and expected future states of PBSA implementation in the USAF, including an assessment of current performance against PBSA goals, the development of forecasts of future performance against PBSA goals, and the evaluation of PBSA contract characteristics. A combination of descriptive statistics, forecasting, contingency tables, and regression were used to analyze the data, draw conclusions, and make recommendations for PBSA implementation improvements. The results conclude that the USAF is not meeting interim PBSA goals and will most likely fall short of the FY 2005 PBSA goal. These results suggest that the goals may not have been reasonable and that the USAF has hit a natural plateau in PBSA use.



Panel – Earned Value Management

Thursday, May 18, 2006	Earned Value Management
2:30 p.m. – 4:00 p.m.	<p>Chair:</p> <p>John Dillard – Naval Postgraduate School</p> <p>Discussant:</p> <p>Nancy Spruill – Director, Acquisition Resources & Analysis, Office of the Under Secretary of Defense (Acquisition Reform)</p> <p>Papers:</p> <p><i>Managing Capabilities Based Acquisition</i></p> <p>COL Raymond Jones, USA Program Manager, Modular Brigade Enhancements</p> <p><i>Measuring Uncertainty in Earned Value</i></p> <p>Richard Suter, RS Consulting</p>



Managing Capabilities Based Acquisition

Presenter: COL Raymond Jones, USA ,Program Manager, Modular Brigade Enhancements

Presentation Only



Measuring Uncertainty in Earned Value

Presenter: Richard Suter

Author Affiliation: RS Consulting, 240-350-7586, rsx@ieee.org

Abstract:

The Department of Defense is transforming its logistics and business systems to become agile, global-in-reach, and readily adaptable to evolving threats—all with significantly reduced Total Ownership Costs. However, the scope and complexity of these systems pose significant technical and programmatic challenges, successful management of which requires accurate engineering, planning, and cost estimation data. Because these programs and systems are information intensive, the costs of data acquisition are governed by the efficiency of communication, coordination and control activities. Likewise, they govern the capability of tools such as Earned Value Management (EVM). Unfortunately, much of the information essential to formulating accurate Planned Value (PV) estimates is not available until after a program is well underway. The key to information/data accuracy lies in the rate and extent to which uncertainty surrounding estimates is eliminated.

The confidence that can be placed in estimates, such as Planned Value, depends on a range of factors—all dominated by the maturity and discipline of Project Management, Quality Assurance, Enterprise Architecture, and Systems Engineering. Unfortunately, measures of their effectiveness have traditionally proven to be hard to implement, hard to interpret, and lack a clear relationship to the accuracy of Planned Value calculations.

However, several observations from Information Theory can be applied to these estimation problems. These include: (1) directly measuring the often unknown and usually unobservable “true” Planned Value parameters; (2) measuring the indirect costs for coordination and control—which represent the vast majority of activity costs for information-intensive organizations and programs—which could pave the way for more efficient and more comprehensive Activity-based Costing.

The strategy employed in this paper is to develop measurement models based on estimation techniques borrowed from Adaptive Control Theory (i.e., for closed-loop systems with unidentified components). The models predict the extent and rate of change (reduction) of uncertainty with respect to the confidence intervals bounding Planned Value calculations. By implication, the reduction (convergence) rate also indirectly measures the efficiency of information utilization of an organization—and, thus, System Effectiveness.

The measurement models outlined in this paper incorporate metrics from standard program management “Dashboards,” (a few of which are provided in the Glossary) along with measures of response delay and uncertainty that can be implemented as a discrete event simulation whose outputs can be compared against project data repositories—such as NASA’s SEL (Software Engineering Laboratory). The benefits of this approach include providing Decision Makers with: (1) “on-demand” capability for assessing both confidence levels for EV estimates, their underlying Planned Value calculations, and other project management parameters; (2) the rate of improvement in those confidence levels; (3) heuristic insight into the dynamics and consequences of decisions for their projects under a range of uncertain conditions.



The proposed measurement models are part of the shift to performance and model-based acquisitions in which cost, performance, and schedule trade-offs are quantitatively integrated to enhance the decision support available to program managers throughout a program's lifecycle.

Key Terms: Earned Value, Planned Value, Information Theory, Enterprise Architecture, Systems Engineering, Adaptive Estimation, Control Theory, Project Management, Information Productivity Paradox

Introduction

Earned Value Management (EVM) enables managers to anticipate problems and to take pre-emptive action. But, EVM implicitly assumes a level of accuracy for Planned Value (PV) that may not be justified, especially at the onset of a project, even for organizations with demonstrated capabilities. This is due to the inherent complexity and scope of the large-scale COTS Acquisition/IT modernization initiatives, rapidly evolving environments environment, and the continual evolution of technology.

However, organizations with strong Program Management and Systems Engineering capabilities can rapidly improve their estimates of project control variables such as scope, risk, schedule, and cost. These capabilities determine the rate at which the uncertainty can be removed from the information employed by an organization. The processes governing these rates and associated uncertainty levels can be modeled using traditional state variable methods and several results from Information Theory. The models generate (indirect) measures of the gap between estimated and “true” (and unobservable) parameter values that quantify the level of non-specificity (uncertainty) of the information resident in PV and related estimates. This provides a basis for determining whether and when enough information is available to satisfy specific confidence levels for estimates. The steady growth of best practices, as advocated by the CMMI, 6-Sigma, OPM3, and the availability of project management tools, indicate that the methods discussed in this paper can be applied at reasonable cost to provide previously unavailable decision support capabilities.

The approach outlined in this paper also scales up to large-scale, COTS-based IT modernization projects, which have minimal software development requirements, but nonetheless a large number of unknowns. For example, a “typical” SAP business system implementation will have thousands of critical parameters, each of which may be associated with a range of interdependencies that generate (unrecognized) ripple effects. Compounding these effects is a range of Information Assurance, Inter-operability, mission and agency-related requirements, undocumented complexities associated with yet-to-be phased-out legacy systems, all in addition to the competing demands of the program's stakeholders. The outcome is substantial integration, cost, performance, and schedule risk that results in the high level of uncertainty that drives the “Information Productivity Paradox.”

The Information Productivity Paradox

The *Information Productivity Paradox* results from technology investments that do not improve productivity, because these investments do not contribute to technical and programmatic integration. That is, the new technology does not eliminate traditional organizational “stove-pipes”). Invariably, this is a consequence of immature organizational processes (e.g., as defined by the CMMI, OPM3, 6-Sigma) that result in poor planning and oversight. The low level of integration exhibited by bureaucratic organizations drives the low



level of rate-of-change and the absence of timely feedback, which limits the capability to “learn,” thus constraining the integration needed to improve productivity. The consequences of this adverse feedback loop include limited capability to control the prime cost driver of *information intensive* organizations—the effort consumed in the coordination and control of information (“10 Myths,” construx.com).

Absent that control, uncertainty levels will be high, thus precluding the “agility” needed to achieve the pre-requisites for accurate EVM. The attributes of that agility include:

- Commonality of data and information processes
- Efficiencies of scale
- Integration across functions
- Availability of real-time information
- Processing efficiency

The relationships underlying these attributes can be expressed as a state variable system of organizational dynamics, using the methods pioneered by Jay Forrester (1999) that can establish the convergence rate of estimated and true Planned Values.

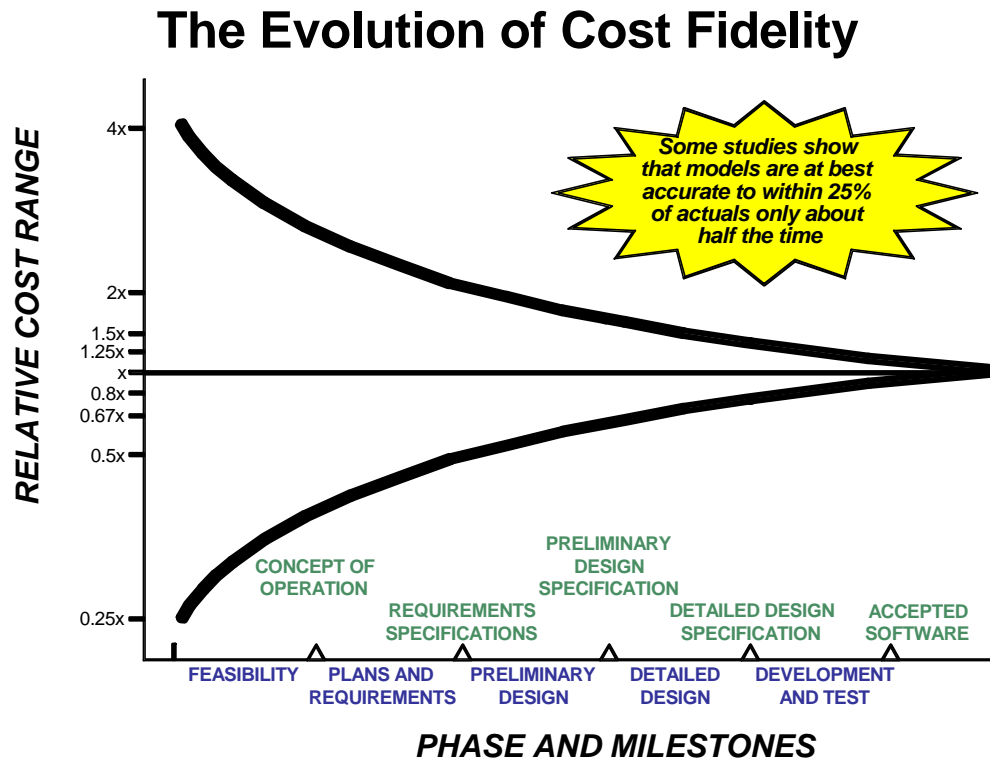
The strategy behind this approach is called “adaptive estimation” and has been applied to a wide range of processing and signal control applications in electrical utilities, manufacturing, and aerospace (Schweppe, 1973), which will be discussed after some basic EVM concepts are introduced.

How EVM Works—An Example

EV measures work—accomplished against a predefined schedule, thus enabling decision makers to systematically assess progress. As the elements of work are completed, their budgets are “earned,” thus quantifying the amount of work accomplished over time. This is Earned Value Management (EVM).



Figure 1. The Evolution of Cost Fidelity (McConnell, 1997, p. 31)



But, EVM assumes that Planned Value data is accurate, a condition that is rarely satisfied at the onset of a large scale IT infrastructure modernization, regardless of capability level. The variability of estimates is particularly pronounced at the onset of an IT modernization project, as illustrated in Figure 2, below.

EV is calculated as follows.

Schedule Variance (SV) is defined as:

$$[4.1] \text{ SV} = \text{EV} - \text{PV}$$

Progress against project schedule can be measured by evaluating [4.1] over a sequence of points in time, noting at each such time point whether $\{SV < 0, \text{ or } SV \geq 0\}$. PV is the *a priori* estimate of the work to be accomplished, and EV is what we observe at the end of each reporting period. If $\text{EV} < \text{PV}$ at the end of a reporting period, then $\text{SV} < 0$ for that period. This means that the project is slipping schedule, and value is not “earned” since work is *not* completed on schedule. But, if $\text{SV} \geq 0$ then work is completed on schedule; so, the dollar value of the budget is “earned.”

For example, if a widget worth \$100.00 is to be delivered at the end of the month (this is the Planned Value), and the widget is completed by the end of the month, the Earned Value is \$100.00, and the Schedule Variance is 0.

But, if the widget is only half completed at the end of the month, then the value earned is $EV = \$50.00$, resulting in $SV = -\$50.00$, which indicates that the project is slipping schedule, since only one-half the PV (Planned Value) was, in fact, delivered, or “earned.”

Similarly, Cost Variance (CV) is defined as:

$$[4.2] \text{ CV} = \text{EV} - \text{AC}$$

So, if the cost of producing one-half of a widget is $\$200.00$ – the Actual Cost (AC), then the CV, from Eqn [4.2], would be $\$50.00 - \200.00 , or $-\$150.00$.

But, these calculations assume that PV accurately represents the “true” workload, which takes time to calculate accurately, even for highly capable organizations, as illustrated in Figure 1. Indeed, the NASA Software Engineering Laboratory (SEL) includes in its estimation process a 40% increase in the estimate of total workload made at project inception that will be needed to complete a project (Suter, 2005).

The variance equations [4.1], [4.2] can be treated as rate equations for closed loop State Variable systems, from which the amount of uncertainty associated with the convergence rates portrayed in Figure 1 can be estimated. To that end, we consider next the construction of a State Variable system.

Rate Equations, Organizational Dynamics and EVM

The complex mixture of organizational time-lagged response rates, transient and steady state conditions generate different time shapes due to delay modulation that varies as a consequence of differing levels of information availability. Rate (action) variables indicate how fast levels of funding, resources, quality, risk, rework, action items, products developed/integrated/delivered, are changing. They determine not present, but future value, as indicated by the rate change in level per unit of time.

The Cost and Schedule variance equations [4.1], [4.2] are rate equations defined by organizational policy, and can be derived using the following methodology:

- ◆ Define the goal (e.g., an objective function defining cost, schedule, quality and other to be optimized (i.e., maximized or minimized as appropriate))
- ◆ Observe the condition of the system (e.g., using methods such as periodic reviews of program progress, burn rates, requirement churn rates, quality, acceptance rates for tasks completed, etc.)
- ◆ Provide the means to express the discrepancy between goal and observed condition; e.g., between “true” Planned Value (PV) and the estimated Planned Value.
- ◆ Indicate what action is to occur, given the discrepancy observed

The rate equations [4.1] and [4.2] are instances of state variable systems which have the general form:

$$[5.2] \quad [dSV(t)/dt] = dx(t)/dt = \mathbf{A} \cdot \mathbf{x} + \mathbf{b} \cdot \mathbf{u} + \mathbf{e}_1 \cdot \mathbf{v}_1$$



$$[dCV(t)]/dt]$$

The composition of the state variable vector, \mathbf{x} , is arbitrary and can consist of standard project variables such as schedule, cost, functionality, risk, quality, performance, each of which could be decomposed into ever finer levels of detail.

\mathbf{A} , the coefficient matrix describes the processing efficiency of the organization in responding to events. It can represent system efficiency as a ratio of Input/Output coefficients as measured in terms of processing rates/hr, tasks completed/week, etc. (To maintain mathematical tractability, it is normally treated as a constant, but can be made function of time.)

$\mathbf{u}(t)$ is the control vector, and consists of adjustments to the state variables as defined by management-concerning factors such as resource and budget allocations, schedules. The effectiveness $\mathbf{u}(t)$ is constrained by situational awareness and organizational capability, and, hence, the quality and timeliness of the information available.

$\mathbf{v}(t)$ is vector of observational errors caused by factors such as incomplete, poor, or delayed information.

\mathbf{b} , \mathbf{d} are vector coefficients of the control variables $\mathbf{u}(t)$, $\mathbf{v}(t)$

\mathbf{e}_1 , \mathbf{e}_2 are vector coefficients of the control variables $\mathbf{v}_1(t)$, $\mathbf{v}_2(t)$

“ t ” is time, and is the yardstick for measuring delay effects, task time, interrupt time, transient and steady state responses, etc. (It is implicit on the right-hand side of [5.2])

Model Based Measures of Uncertainty

Delay is inherent to organizations because information cannot be gathered, analyzed, or transmitted instantaneously. Thus, changes in the environment, slips in schedule may, or may not, be recognized when they occur. For example, decreases in data quality typically generate increased disruption in operation. As more resources are shifted to fixing and correcting data records, the rate at which information is processed decreases. The resulting inefficiency generates increased correction and rework rates, along with increased delays in task completion.

The net effect is a decrease in “situational awareness” that adversely impacts Planned Value calculations. The consequence is a “Nash Equilibrium” which is the point at which the cost of acquiring the information needed to identify a better solution exceeds the perceived benefit (In Game Theory, a Nash Equilibrium occurs when no player has any incentive to unilaterally change his action, since a change in strategy by any one of them would lead that player to “earn” less than if remaining with his current strategy). H. Simon termed this “satisficing” (March & Simon, 1967). The location of that equilibrium point can be inferred by measuring the uncertainty inherent in state variable estimates. Capable organizations (as defined by the CMMI, OPM3, 6-Sigma, etc.) will systematically shift the equilibrium point over the course of a project to one affording more accurate assessments of “true” PV (Suter, 2005).

That convergence is possible because organizational policy drives the level of organizational and technical integration that govern the timeliness and quality of information available to decision makers. Unlike resource flows, information flows are not conserved (i.e., the use information does not deplete it). But, the value of information decays overtime and does



so more rapidly in environments characterized by high levels of Entropy. The impact is especially pronounced for organizations with limited capacity for information processing that reside in rapidly evolving environments.

The interrelationships among these variables constitute a closed-loop feedback system that impacts PV estimates in various ways such as:

- The rate of change (e.g., improvement in the accuracy of PV estimates), while influenced by many factors, can be considered as proportional to delays in decision-making. That is a surrogate indicator of system effectiveness, a key component of which is information processing capability.
- Fluctuations in the variability of (cost, schedule, quality, etc.) estimates are a consequence of (multiple) response lags arising from the interaction of factors such as: open-action items, unmanaged issues, delays in recognizing and adjusting to changes in requirements, scope, budget, market conditions.

(The glossary lists some measures of these factors that could be built from a standard collection of project management dashboard metrics.)

The “damp-out” rates for these fluctuations reflect different adjustment intervals that correspond to the level of organizational integration. Where the integration level is “low,” information transmission delays and distortion rates will result in sub-optimal policy decisions—the “Nash Equilibrium” effect. The consequences include an inability to control the continual stream of transient effects because of the greatly diminished timeliness and the value (quality) of the available information that precludes acquiring a true picture of the situation. Among the unfortunate results is a continual stream of “brush fires” that must be brought under control.

The following Figure illustrates a few of these (overly simplified) feedback dynamics.

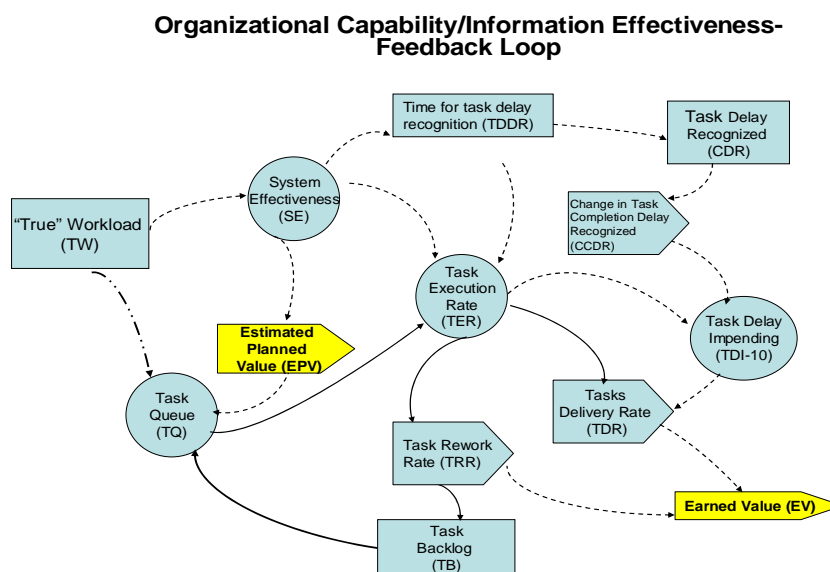


Figure 2. Organizational Capability/Information Effectiveness Feedback System

The key relationships in Figure 2 can be represented as a set of equations comprised of two basic entities:

- (1) Levels - the amount of some quantity
- (2) Rates - the measure of change in level per unit of time.

There are two types of rate:

- (2.1) Controllable: denoted as rectangles pointing to the right (these are the decision variables available to Management)
- (2.2) Not controllable: denoted as circles (which are functions of the controllable rates and their interactions with other rate parameters).

There are two types of delay impact rates:

- (1) Task Execution (physical delay)
- (2) Time to recognize changes (informational delay)

The impacts of the physical rates and levels on the flow of tasks are considered next, while those of information flows are considered in Section 8, below.

$$[6.1] TB_{\text{present}} = TB_{\text{previous}} + \Delta t (TQ - TC)$$

The current Task Backlog (TB_{present}) is the product of the reporting interval, Δt , and the backlog incurred during previous reporting which is defined as the difference between Tasks-in-Queue (TQ) and tasks completed (TC).

TC decomposes into Task Delivered (TD)—those accepted by the customer; and, TR, those not accepted which must be reworked. Thus, if $TD > TQ$, the present backlog is reduced; otherwise, it increases.

$$[6.2] TC = TD + TR$$

Tasks completed is the sum of Tasks Delivered (accepted by the customer) and those to be reworked (TR)

$$[6.3] TQ = EPV + TR$$

Indirectly, TQ depends on EPV (which will vary inversely to accuracy of the resource and time requirement estimate) and the amount of Task Rework (TR)—due to defects, the failure to satisfy requirements, etc. “True Workload” (TW) is unknown because project scope typically is not well defined, requirements are not well understood and are subject to change. While TW is not directly observable, the gap between it and TQ is a function of the amount of (relevant) information available to decision makers—which is a function of overall System Effectiveness, a quantity that can be estimated, as explained in Section 8, below.

$$[6.4] ITD = TB/TDR$$



Impending Task Delays (ITD) can be expressed as the ratio of the Task Backlog (TB) (measured in units) to the Task Delivery Rate (TDR)—measured in units/month, which leaves ITD as an estimate of the time needed to complete backlogged tasks. This delay is based on physical capacity to handle the workload.

There is also a second type of delay based on Entropy/Uncertainty-driven time delays. The first of these is:

$$[6.5] \text{RCTD} = (1/\text{TDDR}) * (\text{ITD} - \text{CDR})$$

Recognized Change in Task Delay (RCTD) is defined as proportional to the difference between ITD and the time required to recognize delay in task completion, labeled as “Completion Delay Recognized” (CDR). The product of this difference and the fraction of Time for Delivery Delay Recognition (TDDR) indicate how quickly an organization can adjust to the gap between ITD and CDR (i.e., to the difference between physically driven and informational delays)—and this is a function of the amount of new information becoming available to decision-makers in each reporting period.

$$[6.6] \text{CDR}_{\text{present}} = \text{CDR}_{\text{previous}} + \text{RCTD}$$

Completion Delay Recognized (CDR) equals the Completion Delay Recognized for the previous period plus the product of the reporting time period, Δt , and RCTD.

$$[6.7] \text{TER}_{\text{present}} = \text{TER}_{\text{previous}} + \Delta t * K_{\text{SE}} * \text{SE}$$

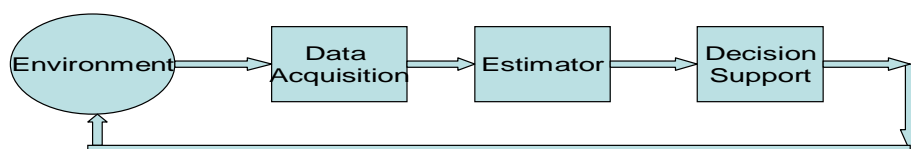
Current Task Execution Rate (TER) is defined as equal to TER for the previous time period plus an amount proportional to System Effectiveness.

The relationships of Figure 2, above, illustrate the role of information flows on system operations and on the capability to develop accurate PV estimates. Assessing that impact is the province of Information Theory.

Information Theory and Its Applications to EV Estimation

For many applications, measures on state variable system parameters are either distorted or are outright impossible. Consequently, the observation process itself must be modeled (in its simplest form the process is illustrated in Figure 3). The first step in modeling estimate accuracy is to distinguish between two general types of noise and their effects. First are those caused by imperfections in the measurement of the output variables; the second are those caused by excluding (simplifying) processes from state space models with the aim of simplifying them. The effects of both must be factored into the models.

Figure 3. The Estimation Environment—Signals, Measurement, Design



Both types of noise can be modeled using any (combination) of the four general estimation models found in the signal processing and statistical research literature. These are: the Fisher, Unknown-but-Bounded, Weighted Least Squares (WLS) and Bayesian. Of these, we shall only consider the first. By way of background, the WLS is limited to correlational analysis, and does not make any assumptions about underlying physical processes, which means that it is of limited value for the purposes of this paper.

While WLS imposes the fewest assumptions, Bayesian models impose the strongest assumptions; namely, all of the state variable parameters have known underlying probability distributions as do its [Bayesian's] corresponding error and observation models. Unknown-but-Bounded (U-b-B) methods assume that observations on \mathbf{x} can be viewed either as means to find: (1) the center of some set, or (2) a point estimate; with the covariance matrix defining the size and shape of the set (often assumed in Signal Processing to be ellipsoid in shape). U-b-B models can be used to analyze systems such as [6.1] – [6.6], where both \mathbf{x} and \mathbf{v} are assumed to be unknown. The Fisher estimation model assumes no a priori knowledge of the vector of state variable vector, “ \mathbf{x} ” (i.e., it assumes no underlying probability distribution, and is thus defined as “unknown”). Only the noise vector “ \mathbf{v} ” is characterized as a random variable (i.e., it has an underlying probability distribution).

The questions of interest in this paper include:

- ▶ What do differences in response times indicate for the accuracy of PV estimates?
- ▶ What does the “time shape” (e.g., attributes such as lag, curvature, frequency, amplitude, variability) of a response indicate about the level of confidence that could be placed in estimate accuracy?
- ▶ When, and under what conditions, can the accuracy of PV estimates be considered acceptable?
- ▶ What effects do modeling errors have on the design and cost of decision support systems?
- ▶ How can measures of information uncertainty be used to establish confidence levels for various parameter estimates? (Klir, 2006—This text provides a comprehensive introduction to Information Theory.)

The first step in answering these questions is to develop a (static) linear estimation model of the observation process:

$$[7.1] \mathbf{z} = \mathbf{H}\mathbf{x} + \mathbf{v}$$

Where:

\mathbf{z} : Is the set of observations on \mathbf{x} as filtered (e.g., “distorted”) by \mathbf{H} and \mathbf{v}

\mathbf{H} : Defines the coefficient matrix of structural relationships defining the observability of the (unknown) state variables, \mathbf{x} , that impact the observations \mathbf{z} . These relationships can be extracted from models such as those outlined in Figure 4, above.



\mathbf{v} : In the Fisher model, it represents disturbances to observation of an uncertain nature, with:

$$[7.2] E \{\mathbf{v}\} = 0$$

$$[7.3] E \{\mathbf{v}^* \mathbf{v}'\} = \mathbf{R}, \text{ which serves as a measure } \mathbf{v}$$

The objective is to find a “best” estimation model that minimizes the error:

$$[7.4] \|\mathbf{x}_{\text{true}} - \mathbf{x}^\wedge\| < \epsilon$$

Where:

ϵ : Is some arbitrarily small amount

\mathbf{x}_{true} : Is not known

\mathbf{x}^\wedge : Is the estimated, and distorted, value of \mathbf{x}_{true} , the “true” value of \mathbf{x} is based on

$\mathbf{z}_{\text{actual}}$: The vector of recorded observation values

$\mathbf{v}_{\text{actual}}$: The actual value of uncertainty in the observation

Using these (redefined) variables, [7.1] becomes

$$[7.5] \mathbf{z}_{\text{actual}} = \mathbf{H}^* \mathbf{x}_{\text{true}} + \mathbf{v}_{\text{actual}}$$

$\mathbf{z}_{\text{actual}}$ and \mathbf{H} are known, but \mathbf{x}_{true} and $\mathbf{v}_{\text{actual}}$ are not known. So, \mathbf{x}^\wedge is constrained to depend on the known terms and on the uncertainty models for the unknown terms. For example, one element of the state variable vector \mathbf{x}_{true} is “True Workload” (TW), while EPV is an element of \mathbf{x}^\wedge ; $\mathbf{v}_{\text{actual}}$ consists of errors in recording observations (observed data values), and \mathbf{H} is the structure of organizational relations that systematically filter/distort $\mathbf{z}_{\text{actual}}$

Using the known terms and candidate uncertainty models, the task is to:

(1) Develop a computational model that best minimizes the error (gap) in [7.4].

(2) Determine how close is to \mathbf{x}^\wedge is to \mathbf{x}_{true} , which has the corollary problem of determining whether and how long it will take \mathbf{x}^\wedge to converge to \mathbf{x}_{true} .

For Planned Value, [7.4] becomes

$$[7.4'] \|\text{TPV} - \text{EPV}\| < \epsilon$$

Which can be read as: the gap between “true” and estimated planned value is acceptably small.

For the Fisher model, the covariance matrix, \mathbf{P} , can be pre-computed independently of \mathbf{z} as follows:

$$[7.6] \mathbf{P}_{\text{Fisher}} = [\mathbf{H}^* \mathbf{R}^{-1} \mathbf{H}]^{-1}$$



The error uncertainty, as measured in terms of the covariance matrix ($\mathbf{P}_{\text{Fisher}}$) can be used to determine whether and when the estimates, \mathbf{x}^\wedge , will satisfy a pre-specified degree of accuracy, even though \mathbf{x}_{true} itself is not observable (Harley, 1928—Harley developed a measure of uncertainty for finite sets, which Shannon adapted to Communications Theory.).

The estimate, $\mathbf{x}^\wedge_{\text{Fisher}}$ is:

$$[7.7] \mathbf{x}^\wedge_{\text{Fisher}} = \mathbf{P}_{\text{Fisher}} * \mathbf{H}^T * \mathbf{R}^{-1} * \mathbf{z}$$

$$[7.8] (\mathbf{N}|\mathbf{N}) \rightarrow \mathbf{P} > 0, \mathbf{R} > 0$$

If [7.8] is satisfied, then the covariance matrix is unique, positive definite, and satisfies Controllability ($\mathbf{Q} > 0$) and Observability ($\mathbf{R} > 0$) conditions—discussion of which is beyond the scope of this paper, except to note that they determine when [7.6], [7.7] will provide satisfactory estimates of \mathbf{x}_{true} . Also, beyond the scope of this paper are the conditions under which ill-conditioned covariance matrices, biased, bounded, weighted, non-optimum estimators, and the conditions under which the “whiteness” of residuals can be used to define estimates that satisfy pre-defined confidence intervals.

Adaptive Estimation—Planned Value Estimation and Uncertainty

The organizational dynamics illustrated in Figure 2, above, constitute an incompletely specified closed loop state space system (i.e., one with unknown components). For these situations, estimates of state variables are updated as new information becomes available. This strategy is known as “adaptive estimation” and can be implemented using any of the standard estimation models, depending on the assumptions we make concerning the physical and information processes of interest.

Schematically, the estimation problem can be portrayed as:

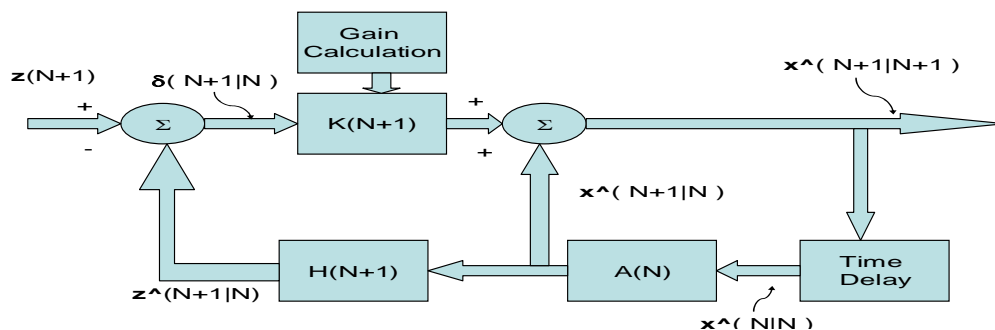


Figure 4. Estimation for Decision Support Systems

The first step in applying adaptive estimation to Planned Value estimates is to note that the state variable model, [5.2], can be represented in discrete time-case state variable model as:

$$[8.1] \mathbf{x}(n+1) = \mathbf{A}(n)\mathbf{x}(n) + \mathbf{G}(n)*\mathbf{w}(n)$$

Assuming \mathbf{H} , \mathbf{A} , \mathbf{G} are known functions of time, [8.1] predicts the system state at time ‘n+1’, over a set of discrete points in time, $n = 0, 1, 2, \dots$

In discrete time form, the estimation model, Eqn [7.5], becomes:

$$[8.2] \mathbf{z}(n)_{\text{actual}} = \mathbf{H}(n) * \mathbf{x}(n)_{\text{true}} + \mathbf{v}(n)_{\text{actual}}$$

$\mathbf{z}_{\text{actual}}$ and \mathbf{H} are assumed to be known, but \mathbf{x}_{true} and $\mathbf{v}_{\text{actual}}$ are not known

The expectation and covariance of \mathbf{v} are:

$$[8.3] E(\mathbf{v}) = 0; \mathbf{R} = [\mathbf{v} * \mathbf{v}']$$

Applying [7.6], an estimator could be defined as:

$$[8.4] \mathbf{W}_{\text{Fisher}} = \mathbf{Fisher} * \mathbf{H}' \mathbf{R}^{-1}$$

Then

$$[8.5] \mathbf{x}^{\wedge}(n)_{\text{Fisher}} = \mathbf{W}_{\text{Fisher}} * \mathbf{z}(n) \quad n = 1, 2, \dots$$

The conditions that would make $\mathbf{W}_{\text{Fisher}}$ a “best” estimator are those of [7.8], above. And, they indicate when \mathbf{x}^{\wedge} (e.g., EPV) is sufficiently close to “true” Planned Value (\mathbf{x}_{true}), as measured against a pre-defined confidence level.

The observations up to time n , $\mathbf{z}(1) \dots \mathbf{z}(n)$ provide an estimate the state $\mathbf{x}^{\wedge}(n+1)$. The following table summarizes the key parameters of the state variable estimation problem, Eqn [8.1], [8.2].

Table 1. State Variable Parameters

Variable	Description
$\mathbf{z}(n)$	Observations of $\mathbf{x}(n)$ filtered by $\mathbf{z} = \mathbf{H} * \mathbf{x} + \mathbf{v}$. Example, if $\mathbf{z}(1)$ is EPV, then the estimate of actual PV is $\mathbf{x}^{\wedge}(1) = \mathbf{W} * \mathbf{z}(1)$
$\mathbf{v}(n)$	Recording errors—observation uncertainty, which may be due to limited or incomplete data
$\mathbf{w}(n)$	Uncertain inputs to organization processes—due to changes in project scope, environment
$\mathbf{A}(n)$	Structural determinants of organizational dynamics
$\mathbf{x}^{\wedge}(n_1 n_2)$	Is the best estimate of $\mathbf{x}(n_1)$ using observations $\mathbf{z}(1) \dots \mathbf{z}(n_2)$ (One element of this vector is Estimated PV)
\mathbf{x}_{true}	Actual system state (i.e., “true” PV, which accurately represents the “true workload”)
$\mathbf{G}(n)$	The (structured) relationships governing the handling of uncertain inputs

H(n)	Structural relationships governing observation (recording) accuracy
“n”	Discrete time points $n = 0, 1, 2 \dots k$
x(0)	Vector of Initial conditions, which may be uncertain, such as a first estimate of Planned Value
R	Observability covariance error matrix with $E\{\mathbf{v}\} = 0$ and with $\mathbf{R} = E\{\mathbf{v}\mathbf{v}'\}$ for the model $\mathbf{z} = \mathbf{H}\mathbf{x} + \mathbf{v}$
Q	$\mathbf{Q} = E\{\mathbf{w}\mathbf{w}'\}$ is the Controllability covariance matrix of uncertain inputs to organizational processes, and $E\{\mathbf{w}\} = 0$

To determine the amount of new information that becomes available to a project, and moves a project closer to satisfying the conditions of [7.9], we define:

$$[8.6] \mathbf{J}(N|N) = \mathbf{J}_{\text{Fisher}}^{-1}(N|N), N = 0, 1, 2 \dots$$

$\mathbf{J}(N|N)$ is the inverse of the covariance matrix is the Fisher Information Matrix, and measures the **amount** of information contained in $\mathbf{x}^{\wedge}(N|N)$; that is, $\mathbf{z}(1) \dots \mathbf{z}(N)$ about $\mathbf{x}(N)$. (A discussion of why this is so is beyond the scope of this paper but can be found in Klir (2006), and Scheweppe (1973).

$$[8.7] \mathbf{X}(N|N) = \mathbf{J}(N|N) * \mathbf{x}^{\wedge}(N|N)$$

Is the **actual information** in $\mathbf{x}^{\wedge}(N|N)$; i.e., is contained in $\mathbf{z}(1) \dots \mathbf{z}(N)$ about $\mathbf{x}(N)$,

where $\mathbf{x}(N|N)$ is read as the state vector \mathbf{x} at time “N” given “N” observations (Scheweppe, 1973, sec. 6.2).

Without going into detail, \mathbf{J} and \mathbf{X} can be used to measure how much information is *lost* due to the presence of uncertain inputs $\mathbf{w}(n)$ to the system. They also provide a means to construct an “Information Discount Rate (IDR)” against which the value and rate of investment in policies, tools aimed at reducing uncertainty, could be assessed. (IDR is a rate used to determine the present value of future [information](#) that can be constructed from estimates of the rate at which “uncertainty” is removed over a succession of estimates. This provides one mechanism to assess various projects estimates.)

System Effectiveness (SE) can be defined as proportional to the ratio of *amount* of change in *new* information acquired between the present time period (N+1) to that acquired in previous time period (N), as measured by [8.8], [8.9], both of which provide feedback to the organizational models of [6.1] - [6.7]. For example, TDDR of Eqn [6.4], above, is dependent on the amount of time required for sufficient information to be acquired for decision making, thus making it proportional to SE, where:

[8.8] $SE = J(N+1)/J(N)$ – measures the percent gain in information between reporting periods N and (N+1). (Other measures are, of course, possible and may prove more useful)

$$[8.9] TDDR = K_3 * SE(N+1) = K_4 * J(N+1)/J(N)$$



Thus, various types of delay such as TDDR can be made explicit functions (changes in information available to decision makers) and can be used to explicitly model the information flows that govern organizational effectiveness as in Eqn [6.5].

Some of these effects, including their impact on the evolution of accuracy of Planned Value estimates, are illustrated in the following graph—using “synthetic” (and “smoothed-out”) data.

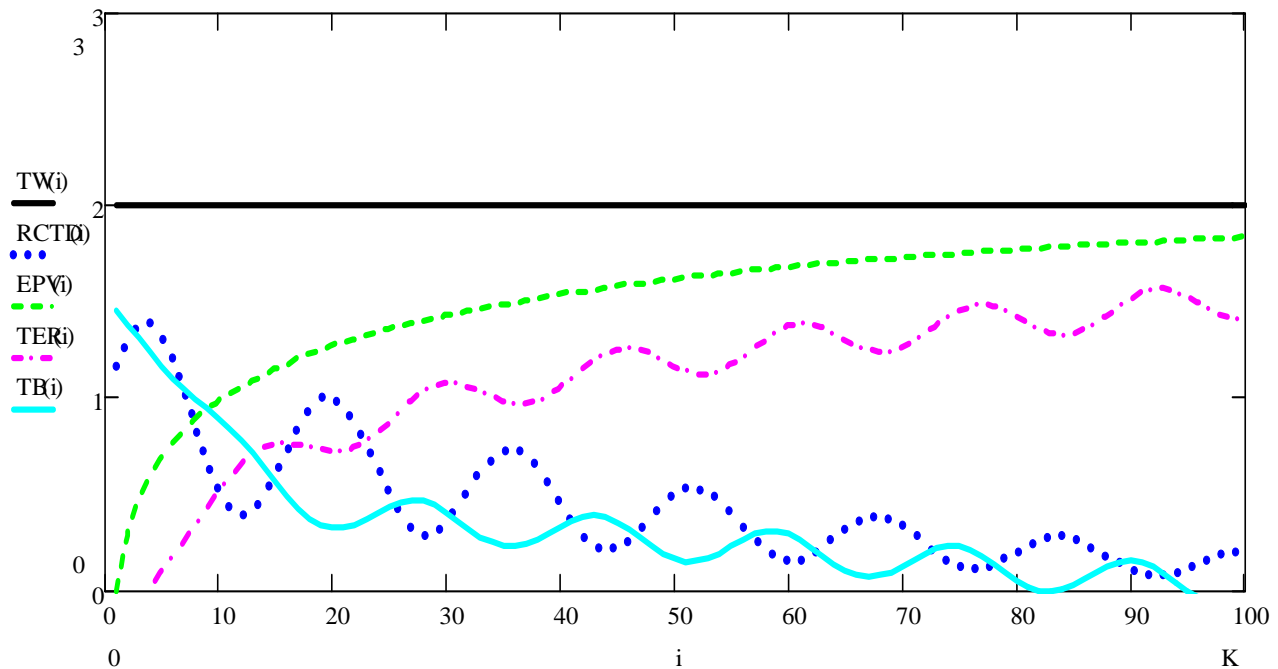


Figure 5. Information Uncertainty Impacts to Planned Value Estimates

The State Variables referenced in Figure 5 are:

TW = True Workload (assumed proportional to True Planned Value)

RCTD = Time to Recognize Delay in Task Completion

EPV = Estimated Planned Value

TER = Task Execution Rate

TB = Task Backlog

The Figure is a heuristic device to illustrate the fluctuations in the coupled feedback loop systems of Eqn [6.1] – [6.7], the interactions of which govern task flows and the associated delays (such as RCTD) in information flows and other system parameters such as task execution rates (TER), and Task Backlog (TB) levels. The interactions determine the rate at which uncertainty (non-specificity) is reduced and, thus, the degree of confidence that can be placed in EV.

Thus, in the Figure, EV steadily approaches “true” PV (with a slope that approximates the inverse of the uncertainty level (entropy), while RCTD and TER share a (coupled) time-lagged oscillation rate that declines over time as does the Task Backlog (TB) level.

Summary

EVM is a valuable tool for managing complex projects, but it rests upon assumptions that can be difficult to satisfy, especially at the onset of a project, and which may never be satisfied by projects with low management capability levels.

However, state variables methods, combined with results from Information Theory can be used to assess the accuracy of Planned Value estimates, the specificity of the underlying information, and, thus, the degree of confidence they merit. These are effects of information/system efficiency that can be inferred from measures such as the variability and time-lagged responses of rate parameters in response to perturbations and shifts in levels of uncertainty.

The next step is to complete and to refine the models, their associated measures, and then validate them against actual project data. Then, they can be implemented as software based tools for use with existing Project Planning tools.

The measurement models outlined in the paper provide the means to provide decision support in a cost-effective manner where they can be integrated with the automated data-acquisition tools; where improvements in organizational capabilities levels are present, the methods outlined in this paper can be implemented.

Glossary

Term	Definition
Activity-based Costing (ABC)	Is based on the assumption that products directly consume activities, not resources. Therefore, the cost of a product is the sum of all the costs of the activities performed to produce that product.
Actual Cost (AC)	The funds spent on work as of some specific date
Controllability	Is satisfied if an input to a system exists which takes the state of the system from any point to any other point in a specified time
Discount Rate	The interest rate used in determining the present value of future cash flows .
Cost Variance (CV)	$CV = EV - AC$
Information Discount Rate (IDR)	The rate used to determine the present value of future information flows that can be constructed from estimates of the rate at which “uncertainty” (i.e., the non-specificity) of the information is removed from estimates provided to decision makers.

Entropy	The uncertainty (non-specificity) resident in information. The formal theory and measurement of uncertainty was first developed by Harley (1928, p. 535-563). Shannon employed the measure to quantify uncertainty in communication systems, and the amount of information needed to reduce that uncertainty acceptable levels. It is a point-wise information metric that quantifies the association strength between 2 events by measuring (in probability terms) the amount of information that event 1 tells us about a second event.
Earned Value (EV)	The measure of work completed within a pre-determined time period. Thus, if the Planned Value of the work to be completed within a month is \$100.00, if that amount of work is completed within that time period, then the budgeted amount for that work is "earned."
Earned Value Management (EVM)	The set of methods, policies and procedures use to estimate EV
Observability	Is satisfied if it is possible to determine the state of a system from knowledge of the output, and input, without knowledge of initial conditions
Planned Value (PV)	The amount of work budgeted for completion within a specific period of time
SEL	Software Engineering Laboratory at NASA, Goddard
Schedule Variance (SV)	$SV = EV - PV$
<i>Organizational Capability Measures include:</i>	
BGCI: The Binary Group Index	Measures whether the vendor passes or fails a group of Binary Exit or Entry Criteria
DAI: Deliverable Acceptance Index	Measures the Quality performance standard for all acceptance-based deliverables. DAI = the number of times a developer submits the final version of a deliverable before approval by the customer
RA/RE: Results Achieved/Results Expected Index	Measures the percentage of expected results actually achieved for results-based deliverables. The type of results will differ by deliverable (e.g., training results for training deliverable, test results for a test deliverable) but the method to collect and assess the results (the RA/RE Index) will be consistent
SVI: Schedule Variance Index	SVI is the difference in the number of days between the expected and actual delivery date for a milestone or deliverable. It provides a schedule performance standard for all deliverables and milestones



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Panel – Contractors in Support of Military Operations

Thursday, May 18, 2006	Contractors in Support of Military Operations
2:30 p.m. – 4:00 p.m.	<p>Chair:</p> <p>Stan Soloway – Professional Services Council</p> <p>Discussant:</p> <p>RADM Lenn Vincent, USN (ret.) – Defense Acquisition University</p> <p>Papers:</p> <p><i>Contractors Supporting Military Operations</i></p> <p>Richard Dunn, University of Maryland</p> <p><i>Going to War with Defense Contractors: A Case Study of Battlefield Acquisition</i></p> <p>Lt Col Timothy S. Reed, USAF, 325th Contracting Squadron, Tyndall AFB</p> <p>Capt Ryan M. Novak, USAF, 21st Space Wing, Peterson AFB</p> <p>Lt Col Bryan J. Hudgens, USAF, Naval Postgraduate School</p> <p>Maj Michael A. Greiner, USAF, 47th Comptroller Squadron, Laughlin AFB</p>

Discussant: RADM Lenn Vincent, USN (ret.), Defense Acquisition University

RADM Leonard (Lenn) Vincent, USN (Ret.), is Vice President and Industry Acquisition Solutions Practice Manager, American Management Systems (AMS), Fairfax, Virginia. He is currently responsible for the development and launch of a commercial contract management system for industry. He also works with senior Department of Defense (DoD) and industry leaders to help identify and develop solutions to acquisition, logistics, and financial management challenges.

Vincent retired from the US Navy after 30 years of service; his last assignment was serving as the Commandant, Defense Systems Management College (DSMC), Fort Belvoir, VA. The college is a graduate-level institution that promotes sound systems-management principles by the acquisition work force through education, research, consulting, and information dissemination.

Vincent entered the Naval Reserve program as a seaman recruit in October 1961. Upon graduation from Southeastern State Teacher's College in Oklahoma, he received a commission in July 1965 from the Officer's Candidate School, Newport, RI, as an ensign in the Supply Corps.



Returning to the Navy in 1970, Vincent had a wide variety of afloat and shore-based assignments that provided him extensive contracting, contract management, and logistics experience.

Afloat, he served as the Supply Officer of an amphibious ship, the USS *Pensacola* (LSD 38), and the Supply Officer of a submarine tender, USS *Dixon* (AS 37).

Ashore, his assignments have included duty as Supply Officer with Naval Special Warfare Group and with Naval Inshore Warfare Command, Atlantic, both in Little Creek, VA. He attended the Armed Forces Staff College, Norfolk, VA; and then in Washington, DC, he earned a Master's in Business Administration from George Washington University.

His varied acquisition assignments include Director of Contracts, Naval Supply Center, Puget Sound; Contracting Officer for the Supervisor, Shipbuilding and Repair, Bath, Maine; Director of the Combat Systems Department and Director of the Contracts Department at the Navy's inventory control point, Mechanicsburg, PA; Assistant Commander for Contracts, Naval Air Systems Command; Deputy Director for Acquisition for the Defense Logistics Agency; and prior to becoming Commandant at DSMC, Vincent was the Deputy Chief of Staff for Logistics, Fleet Supply and Ordnance, Pacific Fleet.

In addition to his last assignment, his command tours have included Commander, Defense Contract Administration Services Region, Los Angeles, CA; Commander, Defense Contract Management Command International, Dayton, Ohio; and Commander, Contract Management Command, Washington, DC.

His military decorations include the Defense Distinguished Service Medal, Defense Superior Service Medal with gold star, Legion of Merit with gold star, Defense Meritorious Service Medal, Meritorious Service Medal with three gold stars, Navy Commendation Medal, and Navy Achievement Medal.



Contractors Supporting Military Operations

Presenter: Richard L. Dunn is currently an independent consultant and Senior Fellow at the University of Maryland. He conducts research and provides advice on business strategies to effectively develop and employ technologies in the military and civil sectors. Mr. Dunn retired from Federal service where he served as the first General Counsel of the Defense Advanced Research Projects Agency and was awarded the Presidential Rank of Meritorious Executive. He also served at NASA Headquarters and was on active duty as a Judge Advocate in the USAF for ten years. At DARPA, Mr. Dunn pioneered contracting using “other transactions” to increase the effectiveness of R&D and prototyping efforts. He is a member of the editorial advisory board of the *Government Contractor*. He has written extensively both in the area of government contracts and military history. Mr. Dunn is a graduate of the University of New Hampshire (*cum laude*), and has law degrees from the University of Maryland and George Washington University (Highest Honors). Mr. Dunn and his wife, Karen, reside in Edgewater, Maryland.

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OVERVIEW

The author's previous research surveyed issues and policies related to the trend toward increased reliance on contractors in combat and other contingency operations, documented relevant case studies, and, presented analyses and recommendations.¹⁸ The current research presents a background summary and updates relevant policy developments since the earlier research. It then takes a distinctly different approach than the earlier study. Instead of trying to extract additional lessons from case studies of current events, this research attempts to gain historical perspective through case studies of earlier conflicts, primarily World War II. Rather than attempting to survey a catalog of issues, this research concentrates on a narrow set of issues.

The issues reviewed in this paper relate to the extent contractors can and should be made an integral part of the “mission team” in combat and contingency operations. If contractors have become integral to the success of combat and contingency operations, shouldn't they be responsive and responsible to the commander formally charged with mission success? Expressed another way, can and should the concept of “unity of command” be applied to contractors in a combat theater? Assuming that contractors should be integrated into joint task force operations in a way that creates the essence of unity of command, how can that be accomplished?

The question of contractor control/unity of command can be relatively simply stated as suggested in the previous paragraph. This research found, however, that the path toward combatant commander control of contractors is complicated by divergent policies, conflicting

¹⁸ Dunn, *Contractors in the 21st Century ‘Combat Zone’*, presented at the Naval Post Graduate School 2nd Annual Acquisition Research Conference (*vide*). Available from the Center for Public Policy and Private Enterprise, School of Public Policy, University of Maryland; and at the NPS website (www.nps.navy.mil/gsbpp/ACQN/publications).



belief systems, disconnections between policy theory and “on the ground” reality, and a variety of legal and regulatory hurdles.

A key aspect of the commander’s ability to control the forces in his theater, uniformed military or civilian contractor, is the ability to direct available forces to perform the most critical tasks when necessary. In a combat zone, the performance of critical tasks may involve activities that constitute or approach “direct participation” in combat. This is not an issue for uniformed military personnel; every soldier can be made a rifleman when necessary. However, civilians who directly participate in combat risk becoming illegal combatants under international law, compromise their potential status as prisoners of war, and potentially become subject to criminal sanctions. Civilian contractors may find themselves participating directly in combat because their contract work calls for such action (e.g., certain weapons system or security contractors) or due to exigent circumstances.

As pointed out in the author’s earlier work, there are a number of issues concerning contractors in combat scenarios that need to be resolved. Policy developments have addressed many of these issues in a variety of ways. Progress continues to be made in a number of areas. Recent developments have not, however, assured that the theater commander has effective control over contractor personnel in his area of responsibility. Current policy purports to prohibit direct participation in combat by contractors; but, there seems to be no rigorous method to ensure that contractors (either as part of contract work or due to exigent circumstances) do not actually participate in combat. Moreover, the concept of “direct participation” is not fixed in international law but is still evolving.

This research aims to examine both these areas and, if possible recommend policies and approaches that will assure that the theater commander and his subordinates effectively control civilian contractors that support them; and, that only uniformed military personnel will actually participate in combat. Both “participation” and “combat” itself may be more amorphous in a war on terrorism than in some other conflicts. A corollary to the commander’s control of the activities of contractor personnel is the concern that civilian contractors that are exposed to the risks of combat receive the same force protection, administrative support, and amenities afforded to soldiers under similar circumstances.

CONTRACT SUPPORT IN COMBAT AND OPERATIONAL DEPLOYMENTS: 1995-2005

Pervasiveness and importance of contract support for operational deployments.

Many recent commentaries on the subject of contract support for combat and other contingency operations begin with a brief historical reference that goes something like: “Contractors have always been on the battlefield; George Washington’s army relied on civilian wagon drivers.”¹⁹ Comments such as that do not convey the improvements wrought by adoption of the contract supply system for the Continental Army nor do they highlight the importance of civilians (primarily seamen on privateers) in combat during the Revolutionary War. Washington’s wagon

¹⁹ For example, a comment to that effect was by made David G. Ehrhart, Brig. Gen. (USAF) at the American Bar Association Public Contract Law Section’s Federal Procurement Institute held at Annapolis, Maryland, March 3, 2006 (hereafter cited as FPI/Annapolis). Some commentators also mention the improvement in supply to the Continental Army after adopting the contract system. See for example, Ferris & Keithly. (2001, September-October). Outsourcing the sinews of war: Contractor logistics, *Military Review*, 72.



drivers and other historical references do, however, suggest questions like, “What is so different today?” and, “Don’t we already know how to do this?”

Actually, things are different today. The international Law of Armed Conflict (LOAC) or laws of war have evolved through a series of treaties, conventions and protocols over the last century. Important elements of international law that affect contract support for combat operations continue to evolve. Domestic law, primarily government contract law, has also developed significantly in recent decades. More immediately, the end of the Cold War and certain business trends since the 1990’s have had major impacts on military force structure and the role of contractors supporting the military.

Victory in the Cold War promised a “peace dividend”, and the Department of Defense contributed by reducing its force structure and its proportion of the Federal budget. The defense industrial base shrank and consolidated significantly. Simultaneously, deployments of military forces in “military operations other than war” as well as combat increased significantly. Then came September 11th and the Global War on Terror which promised to require a high operations tempo for years to come.

From a peak of about 2.1 million, the active force shrank to less than 1.4 million by the year 2000.²⁰ Despite events since September 11th, 2001, recent military personnel strengths are only slightly greater than in 2000, and prospects for large increases are unlikely.²¹ Given shrinking military end-strengths in the 1990’s, a reassessment of force mix was in order. The shrinking military opted to emphasize the fighting “tooth” rather than the supporting “tail” in the new force mix.²² This decision soon led to the additional measure of providing for necessary surge support for military contingencies by contract. The US Army had initiated a policy calling for Army components to plan and contract for logistics and engineering services for worldwide contingency operations in the mid-1980’s.²³ The first actual use of contract support under this “Logistics Civil Augmentation Program” (LOGCAP) came in 1989. In the 1990’s, the Navy and Air Force followed the Army’s lead and entered into worldwide blanket contracts to provide certain types of support for contingency operations.²⁴

A shrinking military and a decision to field more military “tooth” and less “tail” supplies only part of the story for the increase in contracted logistics and combat support functions. For

²⁰ DoD’s active duty military personnel strength, fiscal years 1950-2002. Retrieved from <http://whs.osd.mil/mm/military/ms8.pg#>; at the start of the Iraq war strength was down to 1.3 million.

²¹ Bruner. (2004, May 28). *Military forces: What is the appropriate size for the United States?* Congressional Research Service Report. The Bush administration proposed temporary increases in end-strengths. Actual increases in end-strengths in FY 2005 Defense Authorization Act were limited to 20,000 for the Army and 3,000 for the Marines (sec. 401, Public Law 108-375).

²² Remarks by Robert St. Onge, Maj. Gen. (USA, ret.). (2005, January 28). George Washington University conference: Contractors on the battlefield: Learning from the experience in Iraq (hereafter cited as GWU conference). See also Bruner (note 4), *ibid*. The change is generally ascribed to a decision by Secretary Cohen in 1997.

²³ US Army Material Command (AMC). (2003, August). Pamphlet No. 700-300. *Logistics civil augmentation program* (LOGCAP), p. 4. LOGCAP was initiated by Army Regulation (AR) 700-137 in December 1985.

²⁴ Higgins. (2003, January-February). Civilian augmentation of joint operations. *Army Logistician*, 35. Text contains a description of each service’s program (LOGCAP, AFCAP, and CONCAP).



many years, it has been “the policy of the Government of the United States to rely on commercial sources to supply the products and services the government needs. The Government shall not start or carry on any activity to provide a commercial product or service if the product or service can be procured more economically from a commercial source.”²⁵ In 1966, this policy was incorporated in Office of Management and Budget (OMB) Circular A-76. This policy was honored with varying degrees of support in different Presidential administrations. At times, Congress seemed supportive but at other times attempted to block attempts by government agencies to “contract out” various functions. Broad trends in the 1990’s, both within and outside government, brought “contracting out” or “outsourcing” to the fore.

Within government, at the same time that military force structure and the procurement budget were in decline, the relative importance of DoD service contracting was increasing.²⁶ This was part of a government-wide trend.²⁷

“Contracting out” and “make or buy” decisions are not new business strategies for industry. Recent years have seen a change in the nature and tempo of “outsourcing,” however. According to some estimates, outsourcing in the United States grew “at an annual compound rate in excess of 30 percent” during a five-year period spanning the turn of the Century.²⁸ The subjects of outsourcing have also changed. Once it was common to outsource only “tactical” or “nonessential” parts of a business, allowing companies to concentrate on “core competencies” or the “core business.” A relatively new phenomenon is “strategic outsourcing” where core activities like manufacturing or logistics are outsourced.

It seems safe to assume that outsourcing in the private sector is not a fad but is driven by bottom-line considerations. Within government, there is a philosophical basis for outsourcing services and products available in the private sector (“a government should not compete against its citizens”) but an increase in government outsourcing as well as in “competitive sourcing” (in which increased efficiency, whether in- or out-of-house performance results, is the goal) also has a strong financial motivation.²⁹ The Office of Federal Procurement Policy (OFPP) has estimated that the annual savings from competitive sourcing, if fully implemented, could amount to \$5 billion.³⁰

²⁵ Bureau of the Budget. (1955, January). Circ. No. 55-4.

²⁶ Rush. (2003, May). Performance-based service acquisition. Presentation at 2003 Business Managers’ Conference. Defense Acquisition University. (By 2001, service contracting was over 50% of DOD’s total procurement). According to Robert Lieberman, DoD Assistant Inspector General, between FY1992 and FY 1999, DoD services procurement grew from \$40 billion to \$52 billion (2000, March 16. Testimony. Subcommittee on Government Management, Information and Technology).

²⁷ Bruner, *ibid*, noting that by 2001, services accounted for 60% of total government procurement.

²⁸ CNETNew.com. (2002, September 29). Why outsourcing is suddenly in. Retrieved from www.marketwatch-cnet.com.com/why+outsourcing+is+suddenly+in/2009-1001_3-959785.html

²⁹ “Competitive Sourcing” chapter in Gansler. (2003, June). *Moving toward market-based government: The changing role of government as provider*. IBM Center for the Business of Government. discusses competitive sourcing and gives examples of savings.

³⁰ Safavia, D. Administrator OFPP. (2005, January 25). Letter (no subject) to Richard Cheney, President of the Senate.



Another factor driving toward increased use of contractors in combat support situations is technology. The growing sophistication of DoD systems often requires the expertise of civilian contractors to operate and maintain them. One well known example of this was the public revelation in 1991 that civilian contractors were aboard J-STARS (Joint Surveillance and Target Attack Radar System) aircraft in combat missions during Operation Desert Storm. Civilian personnel flew similar missions in the Balkans.

Civilian contractors have participated in operational missions of unmanned aerial vehicles (UAVs) such as Predator and Global Hawk. They have provided maintenance support for tactical aircraft such as the F-117A Nighthawk. System support contractors even appear directly on the battlefield when they support systems such as the TOW Improved Target Acquisition System.

In Operation Desert Shield/Desert Storm in 1990-1991, over 500,000 military personnel were deployed to the Middle East. The number of civilian employees and contractor personnel (about 14,000) deployed seems modest in comparison. That conflict was fought with the Cold War force structure still in place. The figures are a bit misleading since they overlook the fact that the majority of the transportation (sealift and airlift) that was the means of deployment was provided by civilian carriers.³¹ Dhahran, Saudi Arabia, one of the key points of sealift entry was the target of numerous Scud missile attacks—many of which missed ships and port facilities by relatively narrow margins.

In Operation Joint Endeavor in Bosnia, American civilians (primarily contractor employees) made up about ten percent of the US force committed. US contractors hired an even larger number of Bosnians to perform routine base support services. This was particularly important, however, because self-imposed troop ceilings limited the military presence to 20,000 troops. In counter-drug operations in Columbia, civilians made up about twenty percent of the deployed force. Provision of helicopter support by contract in East Timor in 1999 allowed for the relief of an amphibious assault ship and entire Marine expeditionary unit. Two such ships and units had previously been successively employed to supply helicopter lift in support of the Australian-led mission there.³²

The number of contractor personnel supporting the US Army in Iraq and Kuwait under LOGCAP is about 25,000. Considering that US military personnel in Iraq generally number less than 150,000, this is an impressive figure. This number does not, however, begin to capture the contractor presence in Iraq. In addition to LOGCAP, there are numerous other service contracts administered by weapons system offices or under authority of the theater commander that have a personnel presence in Iraq or Kuwait. Other US Government agencies including the Department of State administer significant contract efforts in Iraq. Suffice to say that many billions of dollars of contracted work and thousands of contractor personnel are part of US efforts to establish a peaceful Iraq that will not harbor terrorists, but will contribute to regional stability and world peace.

What functions do deployed contractors perform? The General Accountability Office (GAO) prepared a list of contractor provided services in different deployment locations as part of

³¹ Matthews & Holt. (1995). *So many, So much, So far, So fast*. Joint History Office JCS, pp. 37-84,115-143.

³² See Dunn (note 1) *op. cit.* for examples of various case studies on recent use of contractor support.



one of its reviews of issues related to contract combat support.³³ One category is base operations support. This includes many mundane tasks once performed by soldiers of a different era (peeling potatoes, cleaning latrines), occasionally power generation, and, a variety of maintenance and “quality of life” support activities. Fuel and material transport were performed by contractors in all deployed locations surveyed by GAO. Management and control of government property was another function performed by contractors in all locations surveyed.

Other functions were performed in some deployed locations but not in others. These included logistics support, pre-positioned equipment maintenance, non-tactical communications, biological/chemical detection systems, continuing education, tactical and non-tactical vehicle maintenance, medical service, and, mail service.

Other services provided by contractors in the GAO list seem much more closely aligned with combat activities. These include weapons systems support, intelligence analysis, linguists, C4-I, and, security guards. These are functions that can obviously be carried out either in the United States or at a deployed location. When they are carried out in a deployed location in conjunction with military operations, some of these activities seem to have the potential to involve contractor employees in something akin to direct participation in combat.

The preceding list includes security guards. These are guards contracted primarily to provide physical security to DoD installations and personnel. Contract security guards are common at both CONUS and overseas DoD facilities. They may be entry or perimeter guards or provide special security to high-value facilities. They are often authorized to carry side arms and sometimes have access to more substantial weapons. In the event of an assault on a DoD installation, they would undoubtedly attempt to repel the attack. In a war zone, the fact that their actions were defensive in nature would not exempt their activities from constituting direct participation in combat.

Not necessarily included within the GAO list are other security personnel. Consistent with DoD policy, many contracts require contractors to provide their own security or “force protection.” Contractors often do this by subcontracting with private security companies who typically employ highly trained professionals, often former US Special Forces/SEAL personnel or experienced foreign nationals. The former head of the Coalition Provisional Authority (CPA) in Iraq, Ambassador L. Paul Bremer, entrusted his security to such firms including Blackwater Security.

Whether under direct contract to a government agency or under a subcontract to a combat support contractor, private security firms have a strong presence in Iraq. By all accounts, in the narrow sense, they have done their job well. Some have questioned, however, whether their presence has had more negative rather than positive impact on the Coalition’s overall goals in Iraq.³⁴ Private security firms have been involved in clashes with both insurgents and US military forces. The most famous incident occurred on 4 April 2004 in Najaf. A small

³³ GAO. (2003, June). *Contractors provide vital services to deployed forces but are not adequately addressed in DoD plans*. GAO-03-695; the relevant appendix can also be found at Dunn (note 1), p. 78.

³⁴ Remarks of Thomas Hammes, Col. (USMC) at GWU conference (note 5). Hammes recounted Blackwater black SUVs racing through the streets of Baghdad running his own military vehicle as well as Iraqi civilian vehicles off the road on more than one occasion. This annoyed (Hammes used a Marine euphemism) many Iraqis in the process and, no doubt, contributed to an unwanted “ugly American” image.

number of highly experienced Blackwater employees and a couple military personnel held off a large number of attacking insurgents and reportedly inflicted numerous casualties. During this operation, the small team of Americans received air support. Helicopters operated by Blackwater pilots delivered ammunition to them while the engagement was still in progress.

Whether cleaning latrines, delivering fuel and ammunition, interrogating prisoners, supporting operational planning, operating UAVs, supporting weapons systems in the field, or, fighting pitched gun battles, contractors are not only present in current US military operations, but provide vitally needed manpower and resources. Absent an unlikely substantial growth and realignment (and return to the draft) of the US military, contractor support for military operations seems destined to continue into the foreseeable future. Contract support is a vital element in the projection of US military power. The question is not whether contractors *should* have such a vital presence in the operational deployments of US forces. The last decade has resolved that question. The key questions are how best to utilize and manage contract support in combat and contingency deployments.

Perceived weakness and inconsistency in DOD policy and management of “contractors accompanying the force.” The author’s previous research highlighted a number of deficiencies or “contracting challenges” related to using support contractors in combat and other contingency operations. Two of these were particularly emphasized. They were (1) the need for training and (2) the need to enhance the contracting authority of the theater and joint task force commander. The current research reinforces those earlier perceptions. However, both areas (and particularly training) are complicated by an over-riding condition, namely, contracting policy often does not fit the reality of the combat zone.

The discussion of training noted that while:

the prisoner abuse at Abu Ghraib may have been unique, the evident lack of understanding about proper relationships and roles for contractors may not be equally unique. Many soldiers at Abu Ghraib thought contractors were supposed to be fully integrated in the chain of command and even assume supervisory roles over military personnel. This view was shared by the OIC of investigations at the prison and even articulated by a field grade Army spokesman who made comments about the situation from the Pentagon.³⁵

The discussion continued: “Support service contracts are hard to manage. Maintaining a team concept between contractor employees and government personnel that work side by side in an office or on the battlefield is important. Maintaining formal distinctions between the two is also required (primarily because personal service contracts are generally not authorized).”³⁶

The “proper roles” and “formal distinctions” mentioned in the previous quotations are those that stem from government contract law and regulations.³⁷ The “team” concept and “chain of command” are personnel management concepts; ones that are particularly important to the

³⁵ Dunn (note 1), *op. cit.*, 60.

³⁶ *Ibid.*, 61.

³⁷ The primary procurement law applicable to DoD components is the Armed Services Procurement Act (10 USC. chapter 137) implemented by the Federal Acquisition Regulation, FAR, (48 C.F.R. Parts 1-53) and the DoD FAR Supplement, DFARS, (48 C.F.R. Parts 201-253).

military. In addition to revealing a deficiency in training, the quotations above may illustrate a divergence between contracting regulations and the imperatives of effectively handling personnel and fighting a war.

Contract vehicles available to support the mission of the combatant commander include external support contracts, systems support contracts, and, theater support contracts. These terms have all been described and examples given in the author's earlier work.³⁸ Systems support involves the operation or maintenance of weapons, surveillance, targeting or intelligence systems which are involved in deployed contingency operations. External support is exemplified by LOGCAP; contracts are awarded and administered by a command other than the theater commander but are intended to provide logistics and other support to the theater commander. Theater support contracts may provide many of the same supplies and services as external support contracts but are under cognizance of the theater commander. All three types of contracting may be referred to as "contingency contracting"; but more narrowly, that term applies to relatively small purchases often in local currency conducted with a minimum of formality but with an understanding of local business customs and satisfying the immediate needs of the troops being supported.

Of the three kinds of combat support contractors mentioned above, only the theater support contractor operates in an environment where lines of contract authority, resource allocation, and the chain of command intersect. Even then, the chain of command and lines of contract authority may not be identical. For other types of contractors (external support and weapons systems contractors) contract authority, resource allocation, and the customer often constitute three different chains of command. In Iraq, this situation was complicated by the presence of other government agencies and their contractors, as well as contractors of the CPA. The combatant commander is responsible for the success of his mission, but he may be dependent upon large numbers of contractors with whom he has no formal contractual relationship but which may have the potential to affect the outcome of his mission.

The evolution of the Army's guidance in this area is of interest. The Army's "Contractors on the Battlefield" (Field Manual 3-100-21, 2003, January—previously FM 100-21 of the same title) emphasizes planning as the key to obtaining effective support from contractors during operations. The Army's earlier guidance notes that generally "multiple contracting agents" will be in the theater dealing with theater support, external support, and systems contractors. The commander is to "integrate and monitor contracting activities throughout the theater." The commander is expressly charged with overall "management and maintaining visibility over the total contractor presence in the theater (battlefield) [...] contracting support is centralized at the highest level to ensure a coordinated approach for operation support."

The 2003 revision of the Army guidance seems to recognize that what was previously required of the theater commander was simply impossible under existing management techniques and policies. Under the revised manual, the commander merely "sets the tone for the use of contractor support" through the planning process. He is to assure "harmony of effort." The commander's principal assistant for contracting (PARC) is responsible only for theater support contracts. This guidance is tantamount to admitting that the theater commander directs contractors through coordination and persuasion rather than command.

³⁸ Note 1, *op. cit.*

Unity of command is one of the principles of war recognized in the US Army Principles of War (1993). According to the military maxims of Napoleon, “Nothing is so important in war as an undivided command” (Military Maxim LXIV)—sometimes translated, “Nothing is more important in war than unity in command.”

In some recent operational deployments, support contractors have made up twenty percent or more of the deployed force. In the case of some specialties, contractors are on scene to operate and maintain key systems that could not operate, or operate as well, without their help. They certainly provide essential logistics support in most operational deployments. Contractors are not merely important but vital to the success of most operational deployments.³⁹

Contractors are important to military success. Unity of command is an important principle of war. We don’t have unity of command with respect to contract combat support. This sounds like a recipe for disaster. No documented disaster has yet happened. How do we account for this anomaly? One hypothesis might be that unity of command is not actually important in this context. Another hypothesis might be that some condition mitigates the lack of unity of command or effectively substitutes for it.

Army policy is clearly stated in “Contractors Accompanying the Force” (Army Regulation 715-9): “contractor employees are not under the direct supervision of military personnel in the chain of command.” This is, of course, consistent with general principles of government contract law that recognize an employee-employer relationship between contractor employees and the contractor but not between contractor employees and the government. Moreover, the contractual relationship between the contractor and the government (so far as direction and control are concerned) is between the contractor and an authorized contracting officer; not the “customer” or beneficiary of the services the contractor provides. In the case of deployed contractors, the cognizant contracting officer might be somewhere in the same theater, but more probably is in another country or on another continent.

The policy is clear; yet, in the Abu Ghraib example, soldiers (including officers) *thought* contractors were in the chain of command. The same belief was held by a US Army spokesman in Washington who stated civilian contractors at Abu Ghraib and elsewhere “fall in line with the current command structure” and are treated just like regular Army personnel.⁴⁰ A spokesman for the contractor involved made a somewhat similar statement: “All CACI employees work under the monitoring of the US military chain of command in Iraq.”⁴¹

There is evidence that beliefs about how contractor employees should relate to the chain of command are not limited to the examples cited above.⁴² Lockheed-Martin weapons system support contractor “employees took nearly all their direction from the field commander.”⁴³

³⁹ Love, M. K. Remarks at FPI/Annapolis (contractors provide “vital” combat support); comments summarized the views of other session panelists. See also note 16.

⁴⁰ Worden. (2004, June 15). Army may be misusing contractors. The-Signal.com (quoting Lt. Col. Pamela Hart)

⁴¹ Ibid.

⁴² Davidson. (2000). *Ruck up: An Introduction to legal issues associated with civilian contractors on the battlefield*, 29 PUB. CONT. L.J. 233 at 266-267.

⁴³ Colby, D. C. (2006, April 12). Lockheed-Martin Orlando, remarks at FPI/Annapolis. Original statement did not include “nearly,” which was added per e-mail correction from Colby.



Government officials have admitted that what's in writing and the way things actually happen may be different; contracting officers may not be directly in control.⁴⁴ "Command and control is more important."⁴⁵

An official for a firm that provided security for officials of the former CPA has stated that things go on daily "outside the scope of the contract. Reality meets the terms of the contract, and they don't match."⁴⁶ His company would "provide a flexible solution." He emphasized the give-and-take needed to make the contract work, stating that it was "not a used car deal"!

Some companies (represented in the Professional Services Council or PSC) operating in Iraq do operate through established lines of contract authority. They found that deployed "contracting officials often lacked authority that was retained by PCOs [procurement contracting officer] and ACOs [administrative contracting officer] in the United States. Contractors found that the terms and conditions of their contracts often dealt inconsistently or erroneously with worker and work place security requirements. The change-order process was slow due to lack of local ACO authority and distances involved. Companies often received conflicting and contradictory directions from their local customer and COR/CO."⁴⁷

A report by PSC companies found "application of FAR requirements involved significant limits and costs that were not always understood particularly by the oversight community."⁴⁸ There was a lack of authority to waive socio-economic clauses that made no sense under the circumstances. The prevalence of undefinitized contractual actions and Defense Contract Audit Agency (DCAA) insistence on immediate audits caused significant problems. The requirements definition process was too decentralized and often disconnected from the contracting and contract administration process. Performance requirements and execution times were often unrealistic and not synchronized with the government's ability to support contractor deployments. The "customer" was not always closely connected to contract execution and established contract roles and responsibilities.

As indicated earlier in this section, some contractors dealt with the disconnection between the "customer" (military in the field) and the established contract lines of authority by following directions from the commander in the field rather than seeking direction from the contracting officer. This practice would seem to risk "constructive changes" in contract work, out of scope performance, and other actions resulting in requests for equitable adjustments in price, claims, disputes and litigation. Available evidence suggests that no unusual amount of litigation is associated with Iraq or other contingency contracting. In the case of the Lockheed-Martin weapons systems support contracts mentioned above, there have been no claims for equitable adjustment.⁴⁹ Some of these were time and materials (T&M) contracts for which the contractor

⁴⁴ Ehrhart (note 2), *ibid.* agreeing with Colby, *ibid.*

⁴⁵ Bachman, M. Assoc. General Counsel, Department of the Air Force. Remarks at FPI/Annapolis.

⁴⁶ Taylor, C. Vice-President, Blackwater USA. Remarks at GWU conference (note 5).

⁴⁷ Dunn (note 1) *op. cit.*, 41 summarizing parts of a briefing prepared by representatives of the Professional Services Council.

⁴⁸ *Ibid.*, p.40; See also Testimony of Soloway, S. (2005, June 32). President, Professional Services Council, Subcommittee on National Security, Emerging Threats, and International Relations, Committee on Government Reform, US House of Representatives, (available from PSC).

⁴⁹ Colby (2006, April 12). Remarks (note 26), *ibid.* Following sentence modified to include "fixed price."



was reimbursed for expenses actually incurred, but some were fixed-price. In other cases, “ratification [after the fact approval] was commonly used.”⁵⁰

Based on the foregoing discussion, it is not unreasonable to conclude that there has been no crisis from the lack of “contract unity of command” because in fact many contractors are following directions of the local command and *acting* as if they were subject to the chain of command. This may be because they *believe* they are subject to the chain of command or merely because it *makes good sense*. In other cases, contracting officers are in the theater and available to make timely decisions coordinated with the local military command.⁵¹

When contractors act as if they are subject to the local chain of command and take their directions accordingly, it does not seem to result in disputes and litigation. This probably stems from the fact that many absentee contracting officers realize they are in no position to give timely or intelligent direction to contractors deployed at a distant and dangerous location. By approving billings for T&M contracts without undue scrutiny or ratifying “unauthorized” contractual actions, contracting officers are endorsing “on the ground” decisions that they are not really in a position to second-guess.

The immediately preceding paragraphs are not meant to imply that the traditional contract lines of authority and contracting rules never work for deployed combat support contracts. Considering that both contractors and government personnel have been steeped in traditional rules for decades, they must sometimes have been made to work in ways approximating normal efficiency. The fact that there are documented reports of disconnects, inefficiency, and apparently considerable instances of ignoring contracting lines of authority, tends to strongly suggest that a preference for contracting rules over military principles may be misguided.

It is hardly comforting to say, “But see, contracting officers do approve out of scope T&M billings and do ratify unauthorized actions; the system does work.” If the DoD intends to operate consistent with policy, out-of-scope T&M billings should not be approved, and ratifications should be rare rather than “routine” and certainly not handled in a way that “encourages such commitments” (FAR 1.602-3 (1)). Strict enforcement of contracting rules might well bring about the crisis flowing from a lack of unity of command that has not yet been apparent. If contracting rules and policies cannot be strictly applied without threatening important military principles, perhaps they need to be seriously reconsidered.

The author’s own recommendations for enhancing the combatant commander’s contracting authority have already been mentioned.⁵² It is worth noting that in addition to the author’s recommendations regarding strengthening the contracting authority of the theater

⁵⁰ Nibley, S. (2006, February 24). Emergency contracting at home and in battle. Presentation at West Government Contracts Year in Review Conference, Washington, DC (hereafter cited as West conference). See FAR 1.602-3 for ratification policy and procedure.

⁵¹ The mere presence of contracting officers in a theater does not guarantee timely decisions. In Iraq, at one point contract oversight personnel outnumbered warranted contracting officers. Some contracting officers were so intimidated and afraid to make a wrong decision that they made no decisions at all. Soloway Testimony (note 31).

⁵² Note 1, *op. cit.*, pp. 63-67, 75-77.



commander, others have made somewhat similar, though not identical, recommendations.⁵³ Additional comments on this will be made in the next section.

Some contractor personnel may *believe* they are subject to the military chain of command. Others may *act as if* they were subject to the military chain of command. This may mask inadequacies in combat support contracting policy. It does not, however, meet the requirements of international law should contractor personnel participate directly in combat.

Contractor personnel are deployed to zones of conflict to operate and maintain sophisticated weapons systems. Others are sent as security guards either to protect government assets or as “force protection” for contractors performing other functions. Others who are contracted to perform only mundane tasks are authorized to carry side arms. These and other categories of contractor personnel may, and have, directly participated in combat. The implications of this flow not only to the individuals involved but to the United States as party to international agreements and LOAC generally, the theater commander, and the companies of the employees involved.

The combination of armed contractors engaging in hostilities, (either pursuant to, or contrary to, authoritative direction) and a military commander in charge of an operational area but not in direct control of contractor personnel has grave implications. LOAC presupposes that violations of the laws of war will be avoided through the control of military commanders that are responsible for their subordinates. When members of a military force violate the laws of war and their theater commander is charged with their crimes, it is no defense for the commander to assert he did not have actual control of his troops.⁵⁴ It is not hard to envisage this principle being extended to the control of contractors that are being utilized as a substitute for, or to augment, a deployed military force.

The United States of America may be tarred internationally by the actions of contractors it has sent to a combat zone. A theater commander and his subordinates may be held criminally liable for the actions of contractor personnel in their area of responsibility.⁵⁵ Companies face civil or criminal jeopardy for the acts of their employees.⁵⁶ One person most unlikely to be subject to criminal sanctions for contractor misconduct is the contracting officer!

Given the implications of inadequate theater combat commander control over contractors and the risks associated with contractors participating in hostilities, one might predict that these issues would be of paramount concern for policy makers. Since operational deployments involve war or, at least a threat of hostile action, one would assume that military

⁵³ Douglas. (2004). Contractors accompanying the force: Empowering commanders with emergency change authority. 31 A.F.L.R. 127; American Bar Association. (2005, October 12). Contractors in the battle space. Section on Public Contract Law. (Report and letter to Principal Deputy to the Assistant Secretary of the Army); DoD proposed rule (2004, 23 March). Contractor personnel supporting a force deployed outside the United States. 69 F.R. 13,500.

⁵⁴ *In re Yamashita*, 327 US 1 (1946).

⁵⁵ *Ibid.* (see comments in preceding paragraph). Military personnel up to the rank of Brigadier General were disciplined for misconduct at Abu Ghraib, some of which involved indirect responsibility for actions of military subordinates and contractor personnel.

⁵⁶ For example, *Nordan v. Blackwater* (No. 5:05-CV-48-FL(1), USD.C., E.D.N.C.) wrongful death action filed against Blackwater Security arising out of incidents at Fallujah, Iraq, in 2004.



principles, such as unity of command, would strongly inform policy developments concerning operational deployments, which would in turn guide the formation of contracting policy to support such deployments. The next section shows this has not been the case.

Recent policy developments and management initiatives. In 2003, the General Accountability Office (GAO) found that there was no DoD-wide guidance on the subject of contractors deploying overseas with military forces and that DoD “has not fully included contractor support in its operational and strategic plans.”⁵⁷ Lack of DoD-wide policy was remedied in 2005. Surprisingly, DoD policy was promulgated not in a DoD Directive but in changes to the DFARS.⁵⁸ Subsequently, a DoD Instruction (“Contractor Personnel Authorized to Accompany the US Armed Forces”, DODI 3020.41, 3 Oct. 2005) was issued requiring use of “contractor support...consistent with the” DFARS. Thus DFARS constitutes top level DoD policy for areas within its coverage. The DODI coverage overlaps the DFARS to a considerable extent and also covers areas not addressed by the DFARS.

The DFARS prescribes a contract clause (Antiterrorism/Force Protection Policy for Defense Contractors Outside the United States, DFARS 252.225-7040) for inclusion in contracts to be performed outside the United States. Certain provisions of this clause address some of the issues discussed in the previous section.

The clause requires contractors to understand that contract performance in support of forces deployed outside the US may require work in dangerous or austere conditions, and the contractor accepts the risks associated with the required contract performance. Another provision states that contractor personnel are not combatants, such personnel shall not undertake any role that would jeopardize their status, and the contractor employees shall not use force or otherwise directly participate in acts likely to cause actual harm to enemy armed forces.

The clause requires contractors to comply with and ensure that its personnel are familiar with and comply with all applicable US, host country, and third country national laws, treaties and international agreements, US regulations, directions, instructions, policies and procedures, and orders and directives and instructions issued by the combatant commander relating to force protection, security, health, safety, or relations or interactions with local nationals.

The most interesting part of the DFARS changes is what they do not contain. As originally proposed (69 Federal Register 13500) language would have vested in combatant commanders authority to order emergency changes in contract performance. This provision was deleted from the final version of the rule. Some comments received in the rule-making process raised concerns about the language. DoD reversed its original position and stated the “proposed language is not consistent with existing procurement law and policy.” Other comments received during the rule-making process supported the recommended change and even suggested clarifying or expanding the proposed authority of the combatant commander as well as vesting subordinate commanders with similar authority. The DoD response nonconcurring with these comments stated “DoD does *not recommend any revisions or expansions to the authorities of the combatant commander*” (emphasis added).

⁵⁷ GAO (note 16), pp. 2-3, 15-20.

⁵⁸ Changes to DFARS Parts 207, 212, 225, and 252; Contractor personnel supporting a force deployed outside the United States. (Effective 2005, June 6). 70 F.R. 23790-23802.



The DoD does not recommend any revisions or expansions to the authorities of the combatant commander. For all the many pages of fine print in the DFARS changes and DoD Instruction, that is the bottom line. The DoD recommends no changes that will enhance unity of command nor increase the combatant commander's control over contractors supporting his operations. New contract language that talks about contractors complying with orders and directions of the combatant commander is not, in fact, intended to expand the commander's authority.

Language in the new contract clause that talks about contractors not being combatants or harming enemy forces may actually contain less substance than first meets the eye. The clause specifically states: "Contractor personnel are not combatants and shall not take any role that would jeopardize their status. Contractor personnel shall not use force or otherwise directly participate in acts likely to cause actual harm to enemy forces" (DFARS 252.225-7040 (b) (3)). Neither the words used nor their context makes these provisions applicable to the contractor. They are directed toward and applicable, by their express terms, to "contractor personnel" who "shall not..." The government has no privity of contract with employees of the contractor. The words are not applicable to the contractor and, since the government has no direct relationship to the contractor's employees, the quoted language is of questionable legal effect at best.

It is probably not too harsh a judgment to say that recent DoD policy fails to enhance the contracting authority of the combatant commander or contribute to unity of command in the least. To the extent recent policy embodied in the new contract clause attempts to address the issue of contractor personnel participating directly in combat, it does so in an inept and ineffective way.

Various provisions of the DFARS and DODI address the subject of "direct participation" by contractor personnel and sometimes seem to conflict. The DODI expressly permits their "indirect participation in military operations" and additionally notes their "inherent right to self defense" (DODI 3020.41, para. 6.1.1). The DFARS does not prohibit contractor personnel from being armed either pursuant to contract or with privately-owned weapons. The discussion of the final rule states the combatant commander will be involved in issues regarding arming contractor personnel on a case-by-case basis. The discussion then concludes by saying that the contractor is "to ensure that its personnel who are authorized to carry weapons are adequately trained. That should include training not only on how to use a weapon, but when to use a weapon" (70 Federal Register 23797). The DFARS states contractor personnel "shall not use force." The DODI says contractor personnel are "authorized to use force" for self-defense (para. 6.3.4.1). The DODI also expressly permits security services to be provided by armed contractor personnel (para. 6.3.5). In the case of ongoing or imminent combat operations, such services are to be used "cautiously" (6.3.5.2).

"Indirect" participation in combat operations allowed by the DODI includes "transporting munitions and other supplies, performing maintenance functions for military equipment, providing security services" (6.1.1); and, as already suggested, there is no restriction from the performance of these functions when combat is "ongoing or imminent." Recent experience has shown that when contractors perform these functions under battlefield conditions, they are likely to be involved in combat. This entitles them to engage in their "inherent right" to self-defense.

Neither the DFARS nor DODI attempts to expressly deal with hard questions concerning "direct participation" that have actually occurred. These include civilians flying combat missions on J-STARS, civilians operating UAVs, repairing weapons under combat conditions, civilian interpreters accompanying military forces in combat operations, or contractors flying on board



aircraft involved in re-supply missions in defended areas. Circumstances constituting “indirect participation,” other than a very few examples given, are left to case-by-case analysis. Moreover, the examples given may, as suggested in the previous paragraph, involve contractors in combat situations. Although both documents require compliance with treaties and international agreements, neither document warns contractors that the concept of “direct participation” is currently in a state of evolution in international law.⁵⁹

It would be wrong to leave the impression that either the DFARS or DODI were solely or even primarily concerned with the issues that are the subject of this paper. In both documents, there is evidence that considerable time, thought and effort was devoted to a variety of issues that affect contingency contracting and the role of contractors supporting a deployed force. Some of the issues might be characterized as “house keeping” type issues, but that is not to say there are not quite important on the practical level. Despite the effort devoted to crafting appropriate DoD policies for contractors supporting military deployments, there are still many unresolved issues. A brief review of some of those issues is included in the next section.

Unresolved issues. The original title contemplated for this paper was “Contractors on the Battlefield: Who is in charge?” In dealing with unresolved issues, before getting down to focusing on issues specific to contracting, perhaps we should inquire, “Defense logistics: Who is in charge, the military department or the combatant commander?” It seems worthwhile to explore the question at least briefly since the obvious dispersion of contracting authority in and out of the area of responsibility and the apparent reticence of DoD to vest the combatant commander with enhanced contracting authority may, in part, rest on a fundamental tension between the authority of military departments (services) and the combatant commanders.

The Secretaries of the Military Departments (specifically the Secretary of the Army in this case) have the following authority:

Subject to the authority, direction and control of the Secretary of Defense and subject to the provisions of chapter 6 of this title, the Secretary of the Army is responsible for, and has the authority necessary to conduct, all affairs of the Department of the Army, including the following functions: ***

- (3) Supplying.
- (6) Servicing.
- (10) Maintaining.
- (11) The constructing, outfitting, and repair of military equipment.
- (12) The construction, maintenance, and repair of [real property assets]. (10 USC 3013)

⁵⁹ The International Committee of the Red Cross (ICRC) which has a key role in overseeing the Geneva Conventions and the development of international humanitarian law has sponsored conferences (Geneva, 2003 and The Hague, 2005) on “Direct Participation in Hostilities” and plans additional conferences. Scholarly writing in this area is increasing. For example see, Schmitt, “Humanitarian Law and Direct Participation in Hostilities by Private Contractors and Civilian Employees”, 5 Chi. J. Int’l L. 511 (2005).

This statutory charter and additional authorities give the Service Secretaries broad discretion in areas involved in or impacting logistics. However, the authority contains a proviso, namely, that it is “subject to chapter 6 of this title.”

The chapter 6 in question deals with combatant commands. Section 165 of chapter 6 expressly states each Service Secretary “is responsible for the administration and support of forces assigned by him to a combatant command.” This responsibility is subject to the authority of the Secretary of Defense and “subject to the authority of commanders of combatant commands under section 164 (c) of this title.”

Section 164 (c) gives combatant commanders, subject only to the authority of the President and Secretary of Defense, functions that include:

(A) giving authoritative direction to subordinate commands and forces to carry out missions assigned to the command, including authoritative direction over all aspects of military operations, joint training, and logistics; (B) prescribing the chain of command to the commands and forces within the command; (F) coordinating or approving those aspects of administration and support (including control of resources and equipment, internal organization, and training) and discipline necessary to carry out the missions assigned to the command.

The statutory authority delineated above would seem to give combatant commanders clear authority “over all aspects [...] of logistics” and “control of resources and equipment [...] necessary to carry out the missions assigned.” A complete treatment of this subject is beyond the scope of this paper. Suffice it to say that combatant commanders do not exercise the unfettered authority over logistics suggested by the quoted statutory language.⁶⁰ According to one commentator, there is a lack of integration that:

results in service program offices, material commands, and inventory control points writing logistics support contracts independently, without considering how to integrate logistics support in the theater of operations and how to handle the ensuing management challenges facing the combatant commander. The presence of contractor personnel in the theater may place the responsibility for their force protection, clothing, housing, medical care, and transportation on the combatant commander, but he lacks the overarching doctrine needed to address the multitude of issues that result from the presence of contractors.⁶¹

A number of issues, some of which were addressed in the author’s earlier research, continue to impact “battlefield” and other contingency contracting. The issues below will be dealt with only briefly, since most have been examined in the author’s earlier paper or discussed above.

Contracting in Iraq has been the subject of exaggerated and irresponsible claims approaching demagoguery by politicians. Repeated charges have been levied against “Halliburton” (actually, Halliburton subsidiary Kellogg, Brown & Root, KBR). Halliburton’s former CEO (Vice

⁶⁰ Paparone. (2005, November-December). Who rules logistics? Service versus COCOM Authority. *Army Logistician*, 37.

⁶¹ McPeak & Ellis. (2004, March-April). Managing contractors in joint operations: Filling the gaps in doctrine. *Army Logistician*, 36.

President Cheney) has apparently made it a convenient whipping boy. Rep. Henry Waxman (D – Calif.) has been among the chief accusers. A pattern has developed in which Rep. Waxman makes public pronouncements and posts information on his website whenever a review or investigation of KBR billings or other action is undertaken, making much of the fact that the Army or an audit agency has initiated an investigation. Later, when KBR is cleared or its billings substantially approved, Rep. Waxman makes public pronouncements to the effect that the “Bush administration” has been soft on its favored contractor. Rep. Waxman has repeatedly referred to Halliburton’s no-bid contract, referring to LOGCAP. An official of competing contractor Raytheon has publicly pointed out that the contract was “fiercely competed.”⁶² KBR and its employees have been involved in some derelictions under LOGCAP and other contracts, but given the immense size of the efforts and conditions involved, this is hardly surprising. Inaccurate and inappropriate political commentary contributes to a faulty public perception of contingency contracting and affects some of the other issues impacting such contracting. Absent a sudden epidemic of honesty among some American politicians, there is little that can be done about this, but it does merit a comment as an unresolved issue.

Flexible contracting vehicles exist to support contingency contracting. Examples of this were documented in the author’s previous paper.⁶³ Two commentators recently agreed, however, that inflexible contracting vehicles and failure to use flexibilities that exist were among the issues common to both Iraq battlefield support and contracting efforts in the wake of Hurricane Katrina. One of the commentators stated this was the number one issue in Iraq battlefield contracting.⁶⁴

The failure to use existing flexibilities may flow from another issue: “Lack of trained acquisition personnel and lack of training for contingency contracting.”⁶⁵ It may also be impacted by: “Unreasonable post-award and in some cases post-performance audit; auditing contingency/emergency contracting using non contingency/emergency standards.”⁶⁶ Excessive contract oversight and oversight conducted using standards inappropriate for the conditions has been documented both in the author’s current and previous research. It is the most likely cause of the “fear to make a decision” syndrome among contracting officers which has likewise been noted. The fielding of large numbers of on-site contract oversight personnel rather than warranted contracting officers seems a serious misallocation of resources.

Much publicized “abuses” and allegations of “fraud” whether by politicians or in the popular press lead “to calls for more oversight and audit scrutiny.”⁶⁷ “Oversight means second guessing”; there is a “need to focus on the front end not the backend,” and we need to get it right next time. “Cooperation, if not partnership, is needed to get the job done.”⁶⁸

⁶² Michael Mutek, remarks at West Conference (note 33).

⁶³ Dunn (note 1) *op. cit.*, 52-55.

⁶⁴ Nibley & Mutek. Emergency contracting at home and in battle. Conference Briefs, 14, from West Conference (note 32). Michael Mutek identified lack of contracting flexibility as the prime issue in his remarks.

⁶⁵ Conference Briefs, *ibid.* Stuart Nibley identified this as his prime issue.

⁶⁶ *Ibid.*

⁶⁷ *Ibid.*

⁶⁸ Remarks by Nibley, S. & Mutek, M. West Conference (note 32).



It should be pointed out that Iraq and other deployments are not merely DoD exercises. The Department of State and other agencies can be major players. Inter-agency efforts and visibility among various agency contractors have not typically been well coordinated. DoD needs to get its policy and doctrine in order. That cannot be done in isolation, however. Other agencies need to be consulted and, ultimately, a government-wide policy formulated. As exemplified by the developments concerning “direct participation in hostilities,” there are international dimensions to be considered as well.

The DFARS change discussed above rejected what was essentially a modest proposal to enhance the combatant commander’s contracting authority.⁶⁹ The rejection was on the basis that the change was not consistent with existing procurement law and policy. Even if the stated basis was correct, it is interesting to note that there have been no subsequent initiatives to modify procurement law and policy to accommodate the kind of change proposed. The procurement status quo was apparently judged more important than the needs of troops and contractor personnel on the battlefield.

The success of our nation’s enterprise in Iraq depends largely on our military presence. Contractors provide a vital part of our military presence. The willingness of contractors and their employees to go to Iraq (and other dangerous places) is based on a mix of profit and patriotism.⁷⁰ In Iraq, contractor employees “live like soldiers;” and in the case of some Lockheed-Martin employees; were under mortar fire for 180 consecutive days.⁷¹ Contractor employees have suffered considerable casualties—including nearly three hundred deaths by one count.⁷² Contractor employees generally consider themselves as part of the “team” and try to be responsive to the local military chain of command.⁷³

Contracting in Iraq works. The fact that it works is based on a *modus vivendi* between contractors and the local military authorities with the apparent acquiescence or benign neglect of some contracting officials. It is not based on the strict application of procurement law and policy. Problems are ironed out based on good will. Out-of-scope changes to contract work are accommodated. Ratification actions are routinely used to retroactively approve otherwise unauthorized actions. In cases where traditional contracting rules are strictly applied, the result is often delay and added expense. It goes without saying that in war, delay in getting needed work done can result in deaths to personnel and mission failure.

If the misguided political criticism and excessive oversight applied to some aspects of Iraq contracting were generally applied to contracting throughout Iraq, it seems certain the *modus vivendi* would break down. The strict application of procurement law and policy could result in a serious decline in the effectiveness of contracting in Iraq and in contingency contracting generally. The rejection of the DFARS change proposal is just one example illustrating that the contracting community is extremely reticent to sacrifice its principles for military principles or the real-world needs of soldiers, contractors and commanders. Apparently

⁶⁹ See Douglas (note 36) for a relatively detailed discussion of the proposed change.

⁷⁰ Dunn (note 1) *op. cit.*, 24.

⁷¹ Colby (note 26) *ibid.*

⁷² Conference Briefs (note 46), 7.

⁷³ Colby (note 26) *ibid.* Dunn (note 1), *op. cit.*, 22-24.



modest proposals for incremental changes have not worked. Perhaps it is time to examine entirely different approaches to providing combat support by contract.

THE PERSPECTIVE OF HISTORY: CASE STUDY SUMMARIES FROM WORLD WAR II AND THEIR LESSONS FOR TODAY

The lessons of history are frequently ignored or misunderstood. Cryptic comments such as “George Washington’s Army relied on contractors. Civilians drove supply wagons” show how facts can be accurate but not tell the whole story or convey an accurate picture. Yes, Washington’s Army did receive supplies from wagons driven by civilian contractors. However, a more revealing fact may be that in 1777 when Washington’s army numbered about 11,000 troops, the Revolutionary War at sea was primarily being fought by about 11,000 civilian seamen serving aboard civilian vessels operating as privateers. United States Navy personnel and ships were but a fraction of a much larger naval effort conducted by privateers. The reference to “letters of marque and reprisal” in the United States Constitution (Art. I, sec. 8, cl. 11) illustrates that war has not always been viewed as an “inherently governmental function” as certain experts have sometimes claimed.⁷⁴ Letters of marque were both grants of authority to undertake belligerent action and “contracts” that allowed profits to be derived from captured enemy shipping. The United States did not accede to the Declaration of Paris (1856) by which many Nations outlawed privateers, but the rise of the United States Navy as a major maritime force in the late Nineteenth Century effectively ended the prospect that additional privateers would be authorized.

Some people believe Viet-Nam was the “wrong war,” but even more would probably agree that it was a “wrongly fought” war. The United States led with its weakest approach by fighting a ground war on the mainland of Asia, something strategists had long-warned against. America’s strong point, its airpower, was shackled with restrictions that dramatically reduced its effectiveness. The Viet-Nam War in general (but particularly the air war over Viet-Nam) was characterized by disunity of command.⁷⁵ Perhaps, as some believe, the ineffectiveness and the disunity of command are related. This may suggest that concern over a lack of unity of command (one theme of this paper) is not merely abstract theorizing over “outdated” military principles but something that should be seriously considered.

World War II may initially seem to be an unlikely candidate for providing lessons about current events and the subjects addressed in this paper. However, in the pre-war and early phases of that war, the United States was resource constrained and had a limited number of men in uniform. Contractors picked up some of the slack. Even when the United States built up to a force of some 12,000,000 personnel in uniform, some functions were so ubiquitous or specialized that civilians performed them.

The case studies in this part of the paper are presented without any undue expectations that they will constitute unequivocal sign posts for current decision makers. It is hoped, however, that they will bring a degree of historical perspective to the subject matter. Some readers may choose to ignore them. Others may find in them some things that speak to the recommendations that follow and show that the recommendations are not merely a rejection of

⁷⁴ FPI/Annapolis. Remarks of Marcia Bachman (pro-inherently governmental and suggesting civilians in combat undermine the President’s commander-in-chief authority) and Michael Love (con).

⁷⁵ For example see, Correll. (2005, December). Disunity of command. *Air Force*, 88.



the current “business as usual” attitude but attempt to incorporate insights from approaches that have worked in the past. At a minimum, it is hoped they will be interesting.

The Flying Tigers. Much information about the Flying Tigers is available. Unfortunately, it exists along side a great volume of misinformation on the same subject. A 1942 motion picture about the Flying Tigers starring John Wayne contained a small dose of fact in an otherwise fictional and inaccurate portrayal. A book about the Flying Tigers published the same year presented a substantially accurate and comprehensive picture of the Tigers and is still worth reading.⁷⁶ Because the US Fourteenth Air Force wore a flying tiger shoulder patch and was commanded by the same man (Claire Chennault) who led the Flying Tigers, the name “Flying Tigers” is sometimes inaccurately applied to anyone or any unit associated with the Fourteenth Air Force in World War II.

The Flying Tigers are famous in large measure because in the early days of World War II when war news was dismal on almost every front, they set a shining example that the Japanese could be beaten. American military leaders sang their praise and very early sought to have them incorporated into the US Army Air Forces. President Franklin Roosevelt said in April 1942: “The outstanding gallantry and conspicuous daring of the American Volunteer Group combined with their unbelievable efficiency is a source of tremendous pride throughout the whole of America. The fact that they have labored under [...] shortages and difficulties is keenly appreciated.”

The facts presented in this case study are drawn from a number of published and primary sources. Most can be found in a few of the best sources.⁷⁷ How is this story relevant to the study at hand? Contrary to myth and misinformation, the Flying Tigers were neither members of the US Army Air Forces nor the Chinese Air Force. They were civilian contractors.

Interestingly, the origins of the name “Flying Tigers” are quite unclear. Almost certainly it had something to do with the shark mouth (Tiger Shark?) design applied to the nose of the group’s Curtiss Tomahawk fighters. Chennault, the group’s leader, professed to be surprised to find that his unit was being billed by that name. However, it was soon in common usage, and the Walt Disney organization eventually designed a logo for the unit showing a winged tiger flying through a V for Victory.

Claire Lee Chennault retired from the US Army Air Corps in 1937 in the grade of Captain. Until April 1942, he held no capacity in the US military other than as a retired regular officer. In 1937, he went to China and became an air adviser to Generalissimo Chiang Kai-shek, head of the Chinese Nationalist Government. Chennault was on the payroll of the Bank of China which was headed by T.V. Soong who was also Minister of Finance and Chiang’s brother-in-law.

⁷⁶ Whelan. (1942). *The Flying Tigers*. New York: Viking Press.

⁷⁷ Whelan, *ibid.*; Chennault. (1949). *Way of a fighter*. New York: Putnam; Ford. (1991). *Flying Tigers*, Washington, DC: Smithsonian Institution Press; Armstrong. (to be published 2006, June). *Preemptive strike*. Guilford, Connecticut: Lyons Press. The website of the Flying Tigers (www.flyingtigersavg.com) and Daniel Ford’s Warbird’s website, which includes an “Annals of the Flying Tigers” section (www.warbirdforum.com), contain valuable resource materials. In the latter case, this includes the author’s article, “Flying Tigers: Heroes, but were they legal?” Some archival material on the Flying Tigers is available on line, the Franklin D. Roosevelt Library and Museum being one source (www.fdrlibrary.marist.edu).

In July 1937, the “China Incident” erupted. The conflict between Japan and China (1937-1941) was a war, but the United States classed it as an “incident”; therefore, the US neutrality laws did not apply, and the depression-weakened US economy could benefit from trade in war goods to both Japan and China. As the conflict went on, the United States’ position gradually shifted toward favoring China. By 1939, the United States had imposed a “moral embargo” against the export of war materials to Japan. Later, the United States imposed legal embargoes against Japan. American loans to China allowed China to purchase war materials from the United States and other countries. In September 1940, Japan aligned itself with Germany and Italy in the Tri-partite Pact. The United States gradually became virtually a co-belligerent with China against Japan.

The Chinese Air Force was often roughly handled by the Japanese. From 1937 to 1940, significant numbers of Soviet “volunteers” and Soviet-supplied aircraft bolstered Chinese air efforts. By 1940, most of the Soviet volunteers were withdrawn. Supplies of Soviet aircraft were drying up, and Soviet fighters made available to China could not compete with the latest Japanese fighters. Late in 1940, Chiang sent a mission to Washington with the mission of revitalizing Chinese air efforts. The mission included Chennault, T.V. Soong, and a general of the Chinese Air Force.

In Washington, the Chinese mission met high government officials. The Secretary of the Treasury and Secretary of State were enthusiastic about supplying a 500-plane air force to China supported by American pilots and ground crews. The US military was less enthusiastic when it heard the plan included supplying the latest B-17 bombers to attack Japan, and pilots were to be recruited from the US Army and Navy. The upshot of this was a loan to China that allowed them to purchase 100 Tomahawk fighters currently under a British contract and eventually permission for Chinese interests to recruit US military pilots. The rest of the plan was delayed and eventually resulted in a few hundred fighters and a hand full of medium bombers reaching the Chinese in the latter part of 1942.

The original idea behind this American air force in China was to tie down Japanese forces in China, disrupt Japanese supply lines, and even attack the Japanese homeland. It was hoped in so doing to make any Japanese move against US interests in Asia difficult, if not impossible. Due to delays and indecisiveness, the only fruits of this plan were to be the fielding of a combat-ready fighter group in Burma by December 1941. This was the “First American Volunteer Group” of the Chinese Air Force, or Flying Tigers.

Aircraft for this unit were 100 Curtiss Tomahawk II fighters diverted from a British order. These are sometimes referred to as P-40Bs and sometimes as P-40Cs. The aircraft were in production as Tomahawk II/P-40C models when the order was switched from Britain to China. Once British specifications for the fighters were no longer applicable, Curtiss decided to incorporate certain parts left over from P-40B production in some of the fighters—making the fighters something of a hybrid model. Armament was supplied later. Two different types of rifle-caliber wing guns (.303 caliber and 7.92 millimeter) were eventually mounted on the fighters, and they were equipped with commercially available radios.

In April 1941, recruitment of American pilots was authorized. This was accomplished mainly through representatives of the Central Aircraft Manufacturing Company-Federal (CAMCO), a company incorporated under the China Trade Act, which operated an aircraft factory and had other interests in China. CAMCO was a subsidiary of Intercontinent Corp. with headquarters in New York. Almost all the pilots recruited were reserve officers serving on active



duty in the Army, Navy or Marine Corps. The exceptions were one Marine regular officer and one Navy enlisted pilot.

The general terms of recruitment authorized for the pilots allowed them to (1) resign their commissions and sever all ties to the US Military; (2) immediately sign an employment contract with CAMCO; and (3) promised, should they later seek it, reinstatement in their branch of service, impliedly at a grade and seniority equal to that of their contemporaries who remained on active duty. Their employment contracts with CAMCO stated they were to “perform such duties as the Employer may direct.” Salaries started at \$600 per month (about three times service pay). Transportation and incidental expenses were authorized. Pilots were required to maintain at their own expense a \$10,000 life insurance policy. In event of death or disability they (or their estates) were to be paid six month’s salary. Travel documents were supplied (none of their passports identified them as pilots). Not included in writing was a promise of a \$500 bonus for each Japanese aircraft destroyed.

About the time the first pilots were being signed up by CAMCO, the first of the crated Tomahawks arrived at Rangoon, Burma. The British authorities permitted workers from CAMCO’s factory at Loiwing, China, to assemble the fighters at an airfield near Rangoon. By the end of July 1941, the first pilots arrived at Rangoon. William D. Pawley, President of Intercontinent and CAMCO, had arranged with the British to turn over Kyedaw airfield near Toungoo, Burma, as a training base for the Americans.

On 1 August 1941, Chiang Kai-shek signed an order constituting the “First American Volunteer Group” to be organized by “Col. Chennault” with the American volunteer fliers now arriving in China in order “to participate in the war.” Although Chennault at that time used the title Colonel, he was a Colonel in neither the US nor Chinese Air Force. Subsequently, he would sign A.V.G. paper work as “C.L. Chennault, Commanding” without any indication of rank. Indeed, neither Chennault nor any of the pilots were at that time members of any air force.

From August to early December 1941, the aircraft and men of the A.V.G. gradually assembled at Kyedaw and began training under Chennault’s expert tutelage. Three squadrons were organized each with a squadron leader and flight leaders. Although military organization and air discipline were adopted, minor military courtesies and regulations were not. During this period, liaison was established between the A.V.G. and Army Air Force officials in the Philippines. As war approached, vital spare parts for the A.V.G. were shipped from the United States and, in some cases, even flown to Asia aboard the Pan American Clipper.

By December 1941, the A.V.G. was preparing to move to Kunming, its base in China. Each squadron in the A.V.G. had at least twenty operational fighters and a slightly larger number of pilots. Training had taken a toll of several Tomahawks destroyed or damaged as well as a couple pilot deaths. A couple more Tomahawks lacked armament, and others were unserviceable due to lack of spare parts. A few pilots had resigned in disgust due to conditions at Kyedaw which included not only minimal facilities but tropical heat, dust, disease and odors.

Soon after the Pacific War began, the A.V.G. flew its first mission. Three Tomahawks, one modified for photographic work, flew a reconnaissance to Bangkok on December 10th. A few days later, Chennault and most of the A.V.G moved to Kunming where, on December 20th, the A.V.G. entered combat for the first time and shot down several Japanese bombers, putting an end to Japanese raids on Kunming for a considerable period. This combat did not make the A.V.G. world-wide news. A report of the combat appeared on page 27 of the *New York Times*.



President Roosevelt's assistant, Dr. Lauchlin Currie, had already recommended that Chennault and his organization be inducted into the US military as a force in being in Asia. The US Army soon began making inquiries along those lines. Chennault began to sound out Chiang's views on the subject via Madame Chiang (who had served as head of the Chinese Aeronautical Commission). Chennault indicated there were certain advantages to China if the A.V.G. were incorporated into the US Army Air Force. These included that China would save money, reinforcements would be more likely, and there would be fewer disciplinary problems among the "enlisted personnel." The "enlisted personnel" were for the most part actually former enlisted men who had been released from active duty along the same lines as the A.V.G. pilots. They, with some personnel recruited in Asia, constituted the technical and administrative staff of the A.V.G. Chennault suggested the issue of discrepancy in pay could be handled by China supplementing the salaries of inducted A.V.G. members until their original contracts expired. The only down-side Chennault mentioned was that an officer unfamiliar with China (meaning someone other than Chennault) might be assigned to command the group. Daniel Ford has pointed out that Chennault was quite prepared to be recalled to active duty in the Army, but not at a rank below Brigadier General.⁷⁸

Meanwhile, one squadron of the A.V.G. had been moved to Mingaladon airfield north of Rangoon. Here, beginning on December 23rd the A.V.G. and a British squadron of Brewster Buffalo fighters met units of the Japanese Army Air Force in a series of clashes over several days. Both sides suffered losses, but the Allies and particularly the A.V.G., claimed spectacular successes. They became front page news. By early 1942, the American volunteer pilots fighting over Burma, soon called the Flying Tigers, were known throughout America.

The Flying Tigers continued to defend Rangoon and southern Burma until early March 1942 when Rangoon fell. In doing so, they operated in coordination with and under the general direction of the local British command. They withdrew to central Burma, and then in April to Lashio. A.V.G. squadrons periodically rotated from China to combat operations in Burma.

Most of the Japanese fighters encountered by the Flying Tigers were fixed landing gear army Type 97 fighters. However, intermittently they clashed with army Type 1 fighters flown by the 64th *Hiko Sentai* (Flying Regiment) that were routinely mistaken for the Japanese navy's Type Zero fighter, the fighter that had devastated Chinese-flown Soviet-built fighters in 1940 and early 1941. Their claims of success over the formidable Zero fighter only added to the luster of their reputation.

The Chinese Army had intervened to help the Allied cause in Burma. By late April 1942, it had been thrown back to the borders of western China and was being hard-pressed by the Japanese in the mountains and gorges bordering the Salween River. Instead of flying air combat missions where Japanese aircraft could be destroyed and \$500 bonuses won, Chennault ordered A.V.G. pilots to strafe Japanese troop columns in the narrow gorges. Similar missions had been ordered and flown earlier in the campaign. Both A.V.G. pilots and planes were pretty worn out by this point, and some pilots' morale was low. This led to a "revolt" of sorts by some of the pilots who refused to fly such missions. Other pilots were called in to fly a few strafing missions, but ground strafing was soon strictly limited.

While the A.V.G. was gaining fame it, was also encountering problems common to many military organizations. In addition to the "revolt" mentioned above, there were many routine

⁷⁸ Ford (note 60) *op. cit.*, 107.

disciplinary problems and some “resignations.” Some of the “enlisted men” brought Chinese women on base and engaged in inappropriate conduct. Some of the pilots declined to fly in combat; others were rowdy and drank too much. There were threats of courts-martial but everyone understood they had no basis. Some men were fired, sent home early. Those that resigned without adequate excuse were considered “dishonorably” discharged. There was no basis for this either, but the concept actually took on meaning many years later. Chennault was left with “disciplinary” measures such as limiting the number of drinks a rowdy pilot was allowed at the Kunming hostel’s bar.

To be plain, the “commanding officer” of this famous and successful fighting unit was actually not even the official supervisor of the men he “commanded.” Chennault was paid by the Bank of China but was acting as an air advisor to Chiang and commander of the A.V.G., ostensibly a unit of the Chinese Air Force. The A.V.G. officially existed as a unit of the Chinese Air Force pursuant to Chiang’s order; however, the A.V.G. pilots and mechanics were not members of the Chinese Air Force or subject to its discipline. They were employees of CAMCO. Chennault had no official relationship to CAMCO. The A.V.G. was not part of the Chinese Air Force chain of command. Chennault reported only to Chiang and was not subject to the corrupt and ineffective Chinese Air Force. Most of the fighting the A.V.G. did was in support of, and under the general direction of, the British in Burma.

The astute reader at this point might note, that “these fellows may have been contractors, but they were contractors hired by the Chinese not American contractors.” Could any lessons to be found in this case study possibly be valid? It is probably more than a minor point that the money China used to buy the aircraft and pay the pilots was borrowed from the United States and probably never paid back; and, that the whole idea of an American air force in China was meant to serve America’s strategic interests. The plot thickens further, however!

In April 1942, Chennault returned to active duty in the US Army Air Forces and was promoted to Brigadier General. This ended his informal contacts with the White House. He now had to report through the theater chain of command. In some respects, Chennault’s status did not change. He remained “commanding officer” of the A.V.G. (of the Chinese Air Force). The time was coming, however, when the A.V.G. would cease to exist and an official US military organization would take its place. Chiang had agreed to this, and the date for transition had been set as 4 July 1942.

By June 1942, American Army pilots were arriving in China and learning the ropes from A.V.G. veterans. They would become the 23rd Fighter Group and successors to the Flying Tigers. Chennault was slated to become the commander of the China Air Task Force of the Tenth Air Force. The 23rd Fighter Group and a small detachment of bombers would report to him. Meanwhile, efforts were underway to recruit pilots of the Flying Tigers into the Army.

Chennault was shunted aside in the induction process, and very few Tigers agreed to sign on as Army pilots. The few that did played key roles in the 23rd Fighter Group. Several other Tigers extended their contracts to fly with the 23rd Fighter Group on its early missions. One was killed in action during this contract extension. Before an appropriate Army officer was found to command the 23rd Fighter Group, Chennault appointed one of his civilian pilots to command the Group! Most of the fighters initially flown by the 23rd Fighter Group were owned by the Chinese and included a fair number of the original Tomahawks that had seen many months of hard combat service with inadequate maintenance.



Pilots of the Flying Tigers received numerous Chinese awards. More remarkably, these contractors received American and British decorations. Chennault was awarded the Distinguished Service Cross. At least ten Tigers received American or British Distinguished Flying Crosses. As will be discussed later, service with the A.V.G. eventually was legally determined to be active duty in the US military. A few weeks ago, Dick Rossi, six victory ace with the Flying Tigers, told me how surprised he was to receive an Honorable Discharge certificate from the US Air Force some years back. Dick never served in the US Air Force or Army Air Forces!

Pacific Base Contractors—Wake Island. The story of Wake Island and the role contractors played there is shorter both in time and in this narrative than the story of the Flying Tigers. Like the Flying Tigers, the Wake Island story was inspirational for the American people in the early days of World War II. Incidents at Wake Island (actually an atoll of three tiny islands) spawned movies of varying degrees of fidelity to actual events (including one starring John Wayne) as well as numerous books, articles, and television retrospectives. The principle sources relied upon for this case study include official histories, popular literature and a primary source document.⁷⁹

To avoid any confusion, the story of the defense of Wake Island in early World War II is primarily the story of heroic and efficient military men commanded by Cdr. Winfield S. Cunningham, USN. The primary fighting units on the island were an under-strength battalion (First Defense Battalion) of Marines commanded by Maj. James Devereux and a similarly under-strength Marine fighter squadron (VMF-211) commanded by Maj. Paul Putnam. The Marine ground troops had arrived only a couple months before war broke out, and the fighter planes arrived only days before the attack on Hawaii.

A Japanese air attack on the first day of the war destroyed the majority of the Marine fighters. Wake Island had no radar, and the defenders were taken by surprise when cloud cover helped mask the approaching Japanese bombers. An invasion attempt a few days later was soundly repulsed thanks to Devereux's coastal guns and attacks by Putnam's remaining F4F-3 Wildcat fighters. The defenders sank two destroyers, put a transport out of action, damaged other warships, and inflicted over four hundred casualties on the Japanese. This news greatly cheered the American public at a time when otherwise all the news was bad.

From the Japanese point of view: "Considering the power accumulated for the invasion of Wake Island, and the meager forces of the defenders, it was one of the most humiliating defeats our Navy had ever suffered."⁸⁰ The Japanese regrouped and prepared for a second invasion attempt when they could receive support from their task force returning from the attack on Hawaii. Meanwhile, the atoll and its defenders were subjected to repeated bombing attacks.

A second landing attempt in the early hours of 23 December 1941 was conducted by stealth rather than direct challenge to Wake's coastal batteries. Japanese landing troops got ashore and fierce fighting ensued with the Japanese troops receiving supporting fire from both

⁷⁹ USG.P.O. (1947). *Building the Navy's Bases in World War II*. US Washington, DC: authro; DoD. (1966). *The Corps of Engineers in the war against Japan*. Office of the Chief of Military History, US Army. Washington, DC: author; Schultz. (1978). *Wake Island*. New York: St. Martin's Press; Bayler, W., Maj. (USMC), Ltr. to Commander-in-Chief, US Pacific Fleet. (dtd. 1942, January 7). Subject: Report on Wake Island. Period of 7th to 20th December 1941.

⁸⁰ Okumiya, & Hirokoshi. (1957). *Zero*. New York: E.P.Dutton (Ballentine ed., p. 86).



ships and aircraft. The outnumbered defenders suffered casualties and were thrown back but, they also inflicted casualties on the Japanese and dislodged them from strong points in counter-attacks. An approaching American task force would be unable to provide any relief to Wake for at least a full day. With the defending force divided, communications unreliable, and unclear how much damage they had inflicted on the Japanese, Cdr. Cunningham bowed to the inevitable and surrendered the atoll.

Before the war, Wake Island was a refueling and rest stop for the Pan American clipper. For about five years, a few dozen employees of Pan Am were the only substantial presence on Wake. Late in 1940, a contract was awarded to the “Contractors Pacific Naval Air Bases” organization for a three-year effort to turn Wake Island into a major naval air base. Construction workers were recruited from men who had worked on big construction projects such as the Hoover and Grand Coulee Dams. The advance party of construction workers arrived on the island in January 1941.

When the first Marines arrived late in 1941, they found they were greatly outnumbered by the construction workers. Devereux’s battalion eventually reached about half strength—or roughly 450 Marines. A service detachment from Marine Air Group 21, the pilots of VMF-211, and other navy men and marines added less than a hundred additional personnel to the military total. Civilian construction workers reporting to contractor superintendent Daniel Teeters numbered about 1,150.

The contractor had dynamite, bulldozers, dredging equipment, and other tools, but the workers were unarmed. Devereux’s Marines began work on defense installations. They were armed, but equipped with little more than picks and shovels for construction work. Short of manpower, the Marines worked in twelve-hour shifts. Teeters’ men continued with their contract work, but Teeters loaned the Marines a bulldozer and other equipment to help them prepare gun emplacements, bomb shelters and defensive positions.

Early in November, Devereux received a warning message: “International situation indicates you should be on the alert.” Devereux sent a return message: “Does international situation indicate employment of contractor’s men on defense installations which are far from complete?” Devereux met with Teeters and Lt. Cdr. Elmer Greey, the military supervisor of construction, and began planning for the use of the civilian contractor work force and equipment to aid in completing high-priority fortifications. Devereux assumed he would be granted permission to employ the contractor’s resources on the highest priority projects. The reply from Pearl Harbor denied Devereux the permission he requested. Devereux could only assume the international situation was not as critical as the earlier warning message had indicated.

Devereux’s battalion was equipped with old weapons, some dating back to World War I; but, it had an impressive array of them. These included six 5-inch guns; twelve 3-inch guns; eighteen .50 caliber machine guns; and, thirty .30 caliber machine guns. Only one of the 3-inch guns came with its full fire-control equipment. The biggest problem was that Devereux did not have sufficient manpower to man all the weapons. His men were also equipped with submachine guns, rifles and pistols, but naval personnel on the island and a small army communications team were unarmed.

On the morning of December 8th, Wake received notice of events occurring in Hawaii (where it was December 7th). Soon, Wake received its first air raid and suffered its first casualties. Wake’s lone Navy doctor was ordered to take over the contractor’s hospital which



was larger than the marine aid station. Teeters and several of his men soon volunteered their services to the military.

On the first day, Teeters and 185 construction workers volunteered their help to the Marines. Teeters kept the volunteers on the payroll and also released equipment and supplies whenever needed. This initial group was soon joined by a hundred others and, eventually, over 300 civilians worked alongside the Marines. Bomb damage was repaired. Food and fuel were dispersed and camouflaged. Empty gasoline drums were cleaned and used to store fresh water.

Teeters took over one of Devereux's major problems by feeding Marines that were now dispersed all around the island. Civilians stood watch along with Marines. Volunteers with no previous military experience received training in weapons so they could replace Marines that might be injured or killed in battle. At one 5-inch battery, a party of 25 civilians helped Marines repair bomb damage and maintain camouflage. The civilians took over all work involved in handling ammunition for the battery.

The 5-inch guns were permanently emplaced. The 3-inch guns were moved to new positions after each (almost daily) air raid. This was done in hours of darkness using entirely civilian labor and equipment. Sixteen civilians under a Marine Sergeant were trained as a gun crew to man a 3-inch gun, which was part of a previously unmanned battery on Peale Island.

Most civilians that did not volunteer to help the Marines continued with their contract work. Unfortunately, the civilians had not learned to disperse during air raids. On December 9th, a Japanese bombing attack hit Camp No. 2; fifty-five civilians were killed. Several others had been lost the previous day.

After beating off a Japanese invasion attempt on December 11th, the defense of Wake was headline news as were the repeated air raids the atoll had suffered. This did not stop construction headquarters in Hawaii from insisting that the dredging of the channel continue and demanding to know when the task would be completed. Other messages seemed to indicate slightly more awareness that Wake was under attack. One message had suggestions for replacing damaged window glass. The barracks buildings that had once had windows had all been destroyed!

During the second Japanese invasion attempt, contractors fought as infantry beside the Marines. Virtually all accounts credit the civilians who actively participated in Wake's defense as making a significant contribution to the action there. Had all the civilians been armed and participated in the atoll's defense, the defenders would actually have outnumbered the Japanese landing forces. Surviving civilians and military, alike, subsequently endured years of brutal Japanese captivity. About one hundred civilian contractors were retained on Wake by the Japanese to act as laborers. They were murdered by the Japanese in October 1943.

Before Pearl Harbor, the Navy Bureau of Yards and Docks began organizing units known as "Headquarters Construction Companies." These units were to be utilized as administrative units by officers in charge of construction at advanced bases in case war interrupted contract operations. Only one such company had been organized by 7 December 1941. It formed the nucleus of the first Construction Detachment which deployed to Bora Bora at the end of January 1942.

With the advent of the war, it became apparent that the services of contractors and their civilian employees could not adequately be utilized for construction work in combat zones.



Under military law, the contractor's forces in their status as civilians could not offer resistance when the bases they were constructing were under attack. A civilian bearing arms would have been considered a guerilla and, as such, would have been liable to summary execution if captured. Furthermore, it was all too clear that civilian workers lacked the training to defend themselves. This was part of the lesson learned at Wake, Cavite, and Guam.⁸¹

At the end of December 1941, the Chief, Bureau of Yards and Docks advised the Bureau of Naval Personnel that construction work at advanced bases could only be satisfactorily carried out by using military personnel under direct military command. It was recommended that early steps should be taken toward organizing military construction forces. Initial recommendations were for three battalions of about a thousand men each.

These recommendations led to the creation of "Construction Battalions"—better known as Seabees. Initially recruitment was directed at men already skilled in the construction trades. Qualified recruits were offered classification as Petty Officers based on their civilian construction experience and age. In the early days of the organization, the average Seabee enlisted with a rate of petty officer, second class, equivalent to an army staff sergeant. Average pay and allowances of \$140 per month made Seabees among the highest paid groups in the military service. By the time Seabee recruitment was modified in December 1942, about 60 battalions had been formed.

Whether or not the rationale quoted above was a strictly accurate reflection of international law, it does accurately reflect some of the motivation for creation of the Seabees. Had the construction workers on Wake Island all been trained to fight and had they been in uniform under military command, there is a high probability Wake Island could have held out longer possibly until a relief effort was mounted.

Merchant Marine and other examples. The formation of the Flying Tigers and the unsuccessful plans to bomb Japan before Pearl Harbor illustrate that the United States had assumed something akin to a co-belligerent status with China against Japan long before the "Day of Infamy." In the Atlantic, the United States moved from providing Great Britain with fifty overage destroyers in 1940, to escorting convoys far across the Atlantic, attacking German submarines, and occupying Iceland in 1941. The German Declaration of War referred to America's "open acts of war" and alleged the United States "virtually created a state of war." One of the few ways Germany could directly strike back at America once war had formally begun was to attack our merchant shipping. This it did with a vengeance.⁸²

The death rate among American civilian mariners in World War II was higher than that among any of the Armed Forces except for the US Marine Corps.⁸³ More than 250,000 officers and crewmen served aboard US merchant vessels in World War II. Over seven hundred ships (each exceeding 1,000 gross tons displacement) were sunk. An estimated 6,800 seamen were killed and 11,000 wounded. At least six hundred others became prisoners of war.

⁸¹ *Building the Navy's Bases*. (note 62), p. 133.

⁸² Bailey, & Ryan. (1979). *Hitler vs. Roosevelt*. New York: The Free Press. Text provides a good review of US diplomatic and naval conflict with Germany in the years between 1939 and 1941.

⁸³ Sources for the merchant marine aspects of this section include *Schumacher v. Aldridge*, C.A. No. 86-2015-LFO, (USD.C., D.C., 16 Jul. 1987); Remarks of Gen. Richard B. Meyers (National Maritime Day Ceremony, 2003, May 22); House Concurrent Resolution 109 (2001, May 21. National Maritime Day).



Merchant vessels kept Britain in the war. Without the lifeblood of supplies carried by merchant ships, Britain would have been forced to capitulate. Winston Churchill remarked that the closest Britain came to losing the war was when the U-boat menace was at its worst. One of the worst moments of the war for the United States came in the early months of 1942 when dozens (145 in 3 months) of American merchant ships were being sunk within sight of the American coastline.

As bad as was the threat posed by enemy submarines, it was not the only threat faced by merchant ships. Merchant ships were also subject to attack by enemy aircraft and surface forces and encountered other hostile conditions. In addition to carrying supplies between ports, merchant ships also participated in amphibious operations along side transports and cargo ships of the Navy. At Leyte Gulf, for example, merchant ships were among the first victims of kamikaze attacks.

A year before Pearl Harbor, the Coast Guard began training merchant seaman in military subjects—including gunnery. Units of the Naval Reserve also provided military training to merchant seaman. By September 1941, gunnery training for merchant crewman on 83 Panamanian flagged vessels had been authorized. In November 1941, Congress ended a Neutrality Act ban on arming US flagged merchant ships. Thereafter, merchant seaman received expanded military training including gunnery, handling barrage balloons, wartime communications, gas warfare, swimming through burning oil, and spotting enemy ships at night.

On some merchant ships, uniformed sailors manned the guns. In such cases, civilian seamen usually were reserve members of the gun crew or ammunition handlers. On other merchant ships, civilian seamen served as the primary gun crews in addition to their other duties.

Wartime brought several changes in status for merchant seamen. Many seamen became Federal employees under the auspices of the War Shipping Administration. The majority of merchant ships were placed under the control of the Army or Navy. The “articles” under which seamen sailed were made less specific and might give a seaman only a vague idea of where a voyage might take him or how dangerous it would be. A seaman who attempted to resign during the course of a voyage or otherwise violated military policy was subject to courts-martial (over 100 merchant seamen actually were convicted by courts-martial).

It is interesting to note that at the same time, one part of the Navy was determining that civilian contract workers were unsuitable for building (and possibly defending) advanced bases, another part of the Navy was intensifying its training of civilian seaman to defend the merchant ships on which they served. It is also interesting to note that while construction workers were intensely recruited and later drafted, members of the merchant marine were exempt from the draft (and in some cases released from military service) on the grounds that they were performing a service essential to the war effort. Admiral Nimitz even referred to the merchant marine as “an auxiliary of the Army and Navy in time of war.”

General Richard B. Meyer’s statement that in Operation Desert Storm, Military Sealift Command and the merchant marine vessels delivered more than 450 shiploads of cargo in seven months amounting to 95 percent of the US cargo required for the war is a recent and telling example as far as the continued relevance of the merchant marine is concerned. General Meyer also noted the work of the merchant marine in Operation Iraqi Freedom, including the strategic implications of its movement of the 4th Infantry Division. It is also interesting that legal authority to arm merchant vessels still exists (10 USC. 351).



Two other brief examples may add some perspective to our inquiry. The first relates to the Coastal Patrol of the Civil Air Patrol.⁸⁴ The Civil Air Patrol (CAP) was created just prior to World War II. CAP volunteers (private pilots and aircraft owners) were contractors in the sense that when they flew missions for the Army Air Force, they agreed to carry out the mission and were allowed access to aviation fuel and reimbursed for certain expenses upon agreed terms. The CAP and its value to the Army was the subject of debates that ranged from whether its activities were worthwhile to whether it should be militarized. Eventually, the CAP proved its utility in a variety of roles.

One mission assigned to the CAP was the Coastal Patrol. The Coastal Patrol was an anti-submarine patrol initiated in response to U-boat incursions close to the US coast that took a heavy toll of merchant shipping beginning in January 1942. This was primarily a Navy responsibility, but in the early days of World War II, the Navy was overwhelmed and the Army was required to share in this mission. The Army too had few resources, and, as a result, a 30-day experiment was authorized during which the CAP's civilian aircraft flown by civilian crews (a pilot and an observer) would supplement the military effort. Some of the more substantial CAP aircraft (Stinson, Waco, Cessna, and other types equipped with 90 horsepower engines or larger) were used for this work. The 30-day experimental program was extended to a 90-day experimental program and then made indefinite. The CAP Coastal Patrol eventually went on for eighteen months—as long as the Army retained a role in anti-submarine warfare.

Missions were flown up to 50 miles off-shore. In initial operations the civilian planes were unarmed. The idea was that they would sight enemy submarines and then radio for assistance. The German U-boats, not knowing the planes were unarmed, usually crash-dived at their approach and eluded armed aircraft arriving later. In one case, a German U-boat crash-dived off the New Jersey coast in shallow water and became stuck in the mud. The CAP plane circled the submarine for an hour as it tried to extricate itself. The plane radioed for help, but eventually the submarine freed itself and went on its way unharmed. Some CAP observers brought their privately owned cameras along and returned with photos of surfaced German submarines and their surprised crews scrambling off the decks to get below and submerge.

Within a few months of initial operations, CAP Coastal Patrol planes were equipped with bomb racks and makeshift bomb sights. After the middle of 1942, the U-boat menace near American shores lessened but did not entirely disappear. CAP continued flying patrol missions until late summer 1943. In some patrol areas, the CAP alternated patrols with the Navy. Other areas were covered exclusively by the CAP. They eventually operated from 21 bases.

This civilian effort was tremendous. The CAP Coastal Patrol flew 86,685 missions involving 244,600 flying hours. It spotted 173 submarines and was credited with destroying or damaging two exclusive of those destroyed by the Army and Navy based on CAP sightings. In addition, it reported 91 vessels in distress and the presence of 17 floating mines. In rescue missions, it was responsible for rescuing 363 survivors and the recovery of 36 bodies. It reported hundreds of irregularities at sea and made over a 1,000 special investigations at sea or along the coast line. At the request of the Navy, it performed 5,684 special convoy missions. During the course of these operations, 26 CAP members lost their lives, 7 were seriously injured, and 90 aircraft were lost.

⁸⁴ Civilian volunteer activities in the Army Air Forces. (1944). Army Air Force Historical Study No. 19.



The final vignette involves Charles A. Lindbergh. Lindbergh was probably America's most famous aviator. His New York to Paris flight was the first solo flight across the Atlantic and captured world attention. Later, he had pioneered international air routes for Pan American. In the years just preceding World War II, he was an outspoken critic of President Roosevelt and his policy of pushing America into an unofficial alliance with Britain against Germany.⁸⁵ Lindbergh was certain this would involve the United States unnecessarily in a European war. Roosevelt had other critics, but few with the influence and star-power of Lindbergh. In April 1941, after Roosevelt publicly questioned his loyalty, Lindbergh resigned his reserve commission. After war, started Lindbergh sought to enter the Army Air Force. Roosevelt would have none of it.

Lindbergh offered his services to various aviation-related companies with whom he had advisory relationships, but the White House made its position known to companies that wanted to play a role in national defense. Lindbergh was unwelcome. Only Ford, in the process of converting from producing cars to bombers, would hire him. He was soon flying and solving problems with aircraft built by a number of different companies.

Eventually in 1944, Lindbergh managed a trip to the South Pacific where he flew fighters on combat missions demonstrating his techniques of cruise control for extending combat range. In flights in Marine F4U Corsair fighters, no enemy aircraft were encountered but Lindbergh did engage in strafing and dive-bombing ground targets as well as flying patrol and bomber escorts totaling fourteen missions. Lindbergh then traveled to New Guinea and demonstrated his techniques to fighter pilots of the Fifth Air Force.

Lindbergh visited units equipped with long range P-38 fighters. He taught them how to get even more range out of their fighters. At the end of June 1944, he began flying combat missions with the 475th Fighter Group. On July 28th, Lindbergh finally ran into enemy aerial opposition and shot down Capt. Saburo Shimada, a veteran pilot and commander of the Japanese army's 73rd Independent Flying Squadron. Shimada was flying a Type-99 Army Reconnaissance plane (*Ki 51*)—a plane much slower but much more maneuverable than the P-38. Before Lindbergh shot him down, Shimada had eluded other P-38 pilots in a series of low-level engagements.

In mid-August, shortly before he was to return to the United States, Lindbergh was officially grounded. The Fighter Group commander that had flown on the mission with him had been reprimanded a few days after the mission on July 28th. Lindbergh had been in New Guinea for nearly two months; and, his flights were hardly a secret, but not until more than ten days after the shoot down was any action taken. Lindbergh suspected the reprimand and grounding had nothing to do with the shoot down. The Fifth Fighter Command had turned down requests to escort bombers to Palau on the basis that the distance was too far and the weather too difficult. Lindbergh's missions with the 475th demonstrated that the P-38 could fly far enough to escort the bombers to Palau. It was official embarrassment over this, rather than risking the life of a national hero that he suspected was the real cause of official displeasure. As far as appears in the record, no one seemed to mind that a civilian shot down an enemy combatant.

⁸⁵ See generally, Charles Lindbergh and the 475th Fighter Group. Retrieved from www.charleslinbergh.com/wwii/.



Current relevance and implications. There can be little doubt that the official position of the US Government during World War II was that, consistent with international law, civilians should not take up arms and directly participate in combat. The creation of the Seabees was in part motivated by this concern. Despite this, these case studies provide several examples of official sponsorship of civilians in combat roles. Before the war, the Flying Tigers were a semi-covert operation. In April 1942, President Roosevelt publicly praised them. The American people may not have been fully informed of their status at that time, but President Roosevelt was certainly aware of it. They would never have been released from active duty and recruited by CAMCO for service in the A.V.G. without Presidential approval. Wake Island and Lindbergh's flights might be considered aberrations authorized by local commanders. Arming the merchant marine and the Civil Air Patrol and sending them on missions where they were likely to encounter the enemy were clearly reasoned decisions made after due governmental deliberation. These case studies seem to indicate an inconsistent attitude toward civilians participating in combat, *de jure* opposed to such participation but, at least on a practical level, permissive.

Some of these case studies suggest that civilians who are subject to no actual military authority or discipline may, nonetheless, act as if they are. It appears that association with a cause larger than the individual, team spirit and a can-do attitude about getting a job done may go a long way toward forming a cohesive group that acts as if it was subject to the chain of command. Informal adherence to the chain of command may be common, but the case studies show examples of derelictions, for example, among some of the Flying Tigers and some contractors on Wake Island.

These case studies illustrate trends stemming back to World War II that are evident in current circumstances and policies as discussed earlier in this paper. Despite an official position against direct civilian participation in combat, current policies do not really create a bright demarcation between direct and indirect participation. We should not be surprised, notwithstanding current policies, if we find instances of civilians participating directly in combat. The possible existence of an "informal chain of command" that masks a lack of unity of command as discussed earlier is supported by ample evidence from these case studies.

The case studies show that despite having some 12,000,000 troops in uniform in World War II, there was still ample room for civilian contractors to play important roles supporting America's warfighting efforts. Rather than an "either-or" or "one size fits all" approach, these case studies show a variety of different approaches to obtaining the needed expertise available in the civilian sector and augmenting military forces with forces of civilians.

In some instances, civilians were put in uniform and asked to perform essentially military functions but at enhanced salaries. The uniform might be that of a quasi-military organization (Flying Tigers) or a special corps of the US Military (Seabees). In other cases, seamen were armed and sent into harm's way in a civilian status but were subject to courts-martial jurisdiction and certain military rules (merchant marine). Civilians were permitted to cross the line between direct and indirect participation in combat when it seemed practical to allow it due to exigent circumstances (Wake Island) or in order to take advantage of specialized civilian expertise (Lindbergh). Direct civilian participation in combat was officially authorized when there was little likelihood the civilians would be captured by the enemy and, thus, held to account for participating in combat (CAP Coastal Patrol).

Some of the examples show that local commanders need to be able to prioritize the tasks contractor personnel perform even if they are outside the normal scope of work of the



contract (Wake Island pre-war). In other cases, it makes sense for the operational commander rather than the contract supervisor to provide day-to-day direction to personnel (Flying Tigers). In many of the examples presented, informal “command” or control was involved; but in other cases a formal military relationship (Seabees) or at least the enforcement of military discipline (merchant marine) was deemed important.

It should be noted that pursuant to law, the service of some civilians can be recognized as “active military service.”⁸⁶ Honorably discharged Flying Tigers, active participants in the defense of Wake Island, and certain merchant mariners are among those whose service has been so recognized. The benefits that flow from such recognition are usually minimal. There certainly is a symbolic significance involved. This form of recognition may also increase the relevance of these case studies to the recommendations below.

Drawing what lessons we can from the foregoing case studies and discussion, the next section suggests policies and approaches that may meet the goals set out earlier in this paper. Those goals are (1) vest actual control over in-theater contractor personnel in the theater commander and his military subordinates, (2) avoid the direct participation of civilians in combat, and (3) treat contractor personnel who are subject to the hazards of combat essentially the same way soldiers are treated so far as force protection, administrative support and amenities are concerned.

ALTERNATIVES AND RECOMMENDATIONS FOR REFORM

Some of the suggestions in this part of the paper will require changes in law, regulations, current policies, and traditional concepts. Decision makers or their staff assistants uncomfortable with such suggestions are hereby put on notice!

A United Kingdom model: The Sponsored reserve. Under Britain’s Reserve Forces Act of 1996, a new category of volunteer reserves was created: the sponsored reserve. The first sponsored reserve unit, the Mobile Meteorological Unit (MMU) was formed in 2000.⁸⁷ The new category changes the relationship between the reservist, their employer, and the Ministry of Defense (MoD). According to Jim Sharpe, Chief Met. Officer at Strike Command:

In a sponsored Reserve Unit there is a three-way partnership, where a company or agency agrees to provide capability and skilled staff through a formal agreement with MoD. The individuals concerned also have an agreement with the relevant arm of the forces to serve for an agreed period, and with the employer who, in the case of the MMU, is responsible for paying the reservist and providing the tools of the trade.⁸⁸

The purpose of the sponsored reserve is to allow the military to make “greater use of skills in the civil sector.” In the case of the MMU, the civilian employer was a government agency. More typically, the employer would be a commercial company.

According to a summary of Authoritative Guidance on the Sponsored Reserve:

⁸⁶ Sec. 401, Public Law 95-202, 91 Stat. 1449 (1977) (codified at 38 USC. 106 note).

⁸⁷ UK Meteorological Office. (2000, October 27). Rapid reaction Met. men to be first sponsored reserves. UK Press Release.

⁸⁸ Ibid.



1. MOD [may] require its contractors to deliver certain designated services by staff who have Sponsored Reserve (SR) status. Thus, a contract for services may be delivered through SRs not only in peacetime but also in operations in a non-benign environment.
2. A SR may either be employed and paid by MOD or remain employed and paid by their civilian employer. The latter option is preferred since it offers the benefit of continuity and reduced administration whilst having no impact on the degree of command and control MOD has over the SR when he [...] is Called-Out or under Service Training.
3. Before SR draft terms and conditions specific to any particular project are offered to tenderers, it is important to ensure that in addition to usual project stakeholders, Centre and single Service Authorities with SR interest are consulted.⁸⁹

The UK Sponsored Reserve approach has a number of interesting features and deserves study. The basic idea of being both in a military status and being paid by a private employer is one that is discussed below. The idea of maintaining military command and control over personnel that are essentially contractor employees is likewise important.

Reserve forces in the UK are structured differently than in the United States. The volunteer reserve (of which the SR is only a small part) makes up only about 15% of the combined total of regular forces and volunteer reserves. In the case of the Royal Air Force, the figure is less than 4%. Neither the structure of UK military forces nor the purpose of the Sponsored Reserve (obtaining civilian skills) make the wholesale importation of the Sponsored Reserve concept into the US military scene necessarily desirable or one that promises a universal solution for all issues related to contracted combat support.

In Britain, the Sponsored Reserve is not primarily used as a means of large scale augmentation of deployed forces but rather to maintain continuity of services performed by civilians in peacetime and assure that deploying support personnel are in a military status. The Sponsored Reserve concept would seem to be a closer fit for deployed weapons system contractors (or other specialists) than for LOGCAP-type contracts. It might be particularly suitable in instances where weapons system contractors are involved in the actual operation of a weapon system or in maintenance and support that can take place on the battlefield. It seems probable, however, that a concept along the lines of Britain's Sponsored Reserve could find, at a minimum, some useful role in the structure of US forces.

Functional control: integrating contractor personnel into the operational team.

One modest change that could help link policy and reality in the operational theater would be to vest functional control and supervision over contractor personnel in commanders subject to the theater chain of command. This would formalize the "informal chain of command" relationship which apparently already exists in many instances.

Functional control is the type of control familiar in matrix organizations and among personnel seconded from one organization to another. In agency and employment law, this type of relationship is recognized in the common law "borrowed servant" doctrine. Examples in civil life include a construction crew from one employer (who currently lacks a project to work on) being transferred to another employer's work site and performing work for the second employer. The construction crew may continue to receive its pay from the first employer, who for many

⁸⁹ Ministry of Defense. (2003, May). Sponsored reserves. United Kingdom: authro.

purposes continues to be the “legal” employer, and take its day-to-day supervision from its normal crew boss. The second employer would specify the work to be accomplished and give general directions. Typically, the second employer reimburses the first employer for the pay and expenses of the “borrowed” employees. Other examples include some types of employment agencies which provide temporary workers to manufacturing or retail establishments. The agency pays the employee, but the receiving employer exercises functional control.

The basic concept of separating the legal and functional relationships between employers and employees is not foreign to the Federal Government where “work with industry,” the Inter-Governmental Personnel Act program, and similar programs have long existed. What is being proposed is actually less extreme than any of the examples just mentioned.

The fact that functional control is vested in a commander in the theater does not mean that the commander or his subordinates will be engaging in relatively close or continuous supervision of contractor employees. The contractor’s own supervisory structure would still be expected to provide day-to-day supervision to contractor employees. The type of functional control exercised would be top-level direction and establishing work priorities that impact mission accomplishment.

What is essentially being suggested is modifying the following theoretical chain of direction where: (1) the “customer” in the theater communicates its needs and priorities (2) to a non-resident contracting officer who validates them and then communicates them (3) to a contractor point of contact who then passes them (4) to the contractor personnel who are in theater. There are delays inherent in such a chain. Most likely (1) and (4) are in close contact, and between them the most accurate communication takes place. In a functional chain of direction, (1) would communicate directly to (4) on a real time basis. Information would be supplied to (2) and (3) who could provide guidance if local direction varied from contract terms. In instances where such was the case, (1) and (4) would be informed accordingly and the variance would be corrected, the action ratified, and/or the contract modified to reflect local conditions.

Based on research documented in this paper, what is suggested here does not actually change what is taking place; it merely recognizes it as a fact and endorses it as a rational approach to the control and management of contractors in deployment situations. It seems quite possible to implement this suggestion with appropriate contract language and delegations of authority.⁹⁰ Regulatory changes expressly recognizing the propriety of this type of relationship might be necessary, however, to overcome the entrenched views and resistance likely to be encountered from contracting officials.

This recommendation is not intended to create a personal service contract relationship between the theater command and the contractor’s personnel within the meaning of FAR 37.104. Nothing more is intended than to make official the unofficial relationships that are currently evident.

⁹⁰ Broad authority to delegate procurement functions is found at 10 USC. 2311. Even if a deviation from the FAR or DFARS is deemed necessary to effect this recommendation, that should not inhibit its implementation (FAR 1.402).



Temporary militarization of contractor personnel. Given that the definition of “direct participation” in combat is evolving and that some of the functions that have been performed by contractors, or that may be performed by contractors in the future, could cross the line between indirect and direct participation in combat, it is important to find ways to protect the individuals involved as well as for the United States to comply with its responsibilities under LOAC. One way to do this would be to temporarily grant military status to contractor personnel performing functions or in circumstances involving a significant possibility of direct participation in combat.

One approach would be to establish a new category of military reserve or militia service to which certain contractor personnel would be subject as a condition of their contract employment. The statute establishing this type of service would limit the number of personnel that could actively serve in it but not count them against either the active or reserve strength of the Armed Forces serving under standard legal authorities.

Contractor employees identified for potential activation under this authority would receive at least the minimum training in LOAC and other subjects in order to comply with international law as well as a basic form of military training. Training would be conducted pursuant to government standards. The intent is for activation under this authority not only to be temporary but intermittent, that is, military status would be conferred only when there was an actual possibility of being directly involved in combat. Personnel would be subject to the Uniform Code of Military Justice and other applicable military regulations when in an active status and at other times with respect to actions occurring while in an active status or relating to it.

The uniform worn and standards of appearance for these personnel should be essentially the same as for other military personnel. They would have some form of distinctive insignia. They should have a distinctive rank titled “Technician” or some similar term, as well as a class of rank applicable for protocol but not command purposes (except with respect to others in a similar status). They should be exempted from Federal statutes incompatible with the temporary and intermittent nature of their service or incompatible with their on-going relationship with their private employer. They would be issued military identification cards and afforded access to military health and welfare programs while in an active status. Their military status would end with their death or disability, which would be handled under the terms of their civilian employment relationship.

Their pay and allowances would be a continuation of their employer’s pay plan or a system could be devised similar to the UK Sponsored Reserve where compensation expenses upon activation could be paid by the employer, the Government, or, some combination. Simply continuing the employer’s pay plan would probably be the simplest approach in most cases.

Critique of the recommendations. The version of this paper presented at the Naval Post Graduate School Acquisition Research Conference is very much presented in order to generate discussion and critique of the ideas presented. Comments on the recommendations as well as other aspects of the paper are solicited.

One criticism that might easily be made, for example, is that introducing three different types of changes (or at least two types of changes relating to new classes of military personnel) is just going too far and too confusing, irrespective of the merits of any individual recommendation. Alternatively, one might argue that the case has been made for much more extensive changes and the recommendations fall short of expectations.

Finally, it is recognized that the devil is often in the detail. Comments and criticism directed at details affecting possible implementation of the recommendations are also sought.



Going to War with Defense Contractors: A Case Study of Battlefield Acquisition

Presenter: Lt Col Timothy S. Reed, USAF

Capt Ryan M. Novak, USAF

Lt Col Bryan J. Hudgens, USAF

Maj Michael A. Greiner, USAF

Abstract

The escalating use of contractors on the battlefield in highly critical operational areas is a trend that is increasing across the DoD. Contractors have a vital role supporting CONUS missions, but they are also on the battlefield in defense of our nation, supporting the warfighter and their weapon systems. As the use of contractors on the battlefield continues to gain favor within the DoD, and as contractor's roles continue to expand and become more critical, it is imperative to improve the current way that the DoD, and specifically Air Force acquisition professionals, procure such services. This research analyzes inputs from DoD Policy Experts, Contractor Policy Experts, Army Policy Experts, Air Force Policy Experts, and 13 Air Force Program Offices that use contractors on the battlefield to support, maintain, and/or troubleshoot their weapon systems. Content analysis and pattern matching were used to determine the current status of battlefield acquisition, draw conclusions, and make recommendations. Several problem areas in this area of acquisition were identified as well as best practices and lessons learned.



An Exploratory Study of Contracting Performance by Untrained Individuals

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Abstract

This paper reports on an experimental study where 178 student subjects without formal training in contracting issues were asked to accept or reject each of 20 clauses of a software purchasing contract. The subjects used a Web-based interface to accept or reject clauses. Of the 20 clauses in the contract, 6 were intentionally deceitful, in the sense that they specified binding obligations that made it unadvisable to accept them as part of a contract. On average, the subjects were able to correctly accept approximately 11 out of 14 non-deceitful clauses. Somewhat surprisingly, the subjects were able to correctly reject only 2 out of 6 deceitful clauses. The study also suggests that, among untrained individuals, those who are older, have more general work experience, and have above-average scholastic ability are the ones more likely to perform well in contracting tasks under conditions similar to those found in this study (i.e., Web-based contracting conditions). This study's findings provide the basis for a strong call for more and better training of contract officers in the DoD.

KEYWORDS: Electronic Commerce, Electronic Trade, Web-based Contracts, Software Purchasing, Communication Media, Media Naturalness

Introduction

Recently there have been renewed calls (see, e.g., Friar, 2005) for more and better training of contract officers in the US Department of Defense (DoD). Without appropriate training, serious contractual mistakes may be made, some of which are likely to place the DoD in a situation where it is legally bound to abide by adverse contract clauses. Given the large dollar amounts involved in many of the DoD's contracts, the financial consequences of such mistakes can be significant.

Several technological developments in the last 20 years led to a significant growth in the number of instances of situations in which products and services are purchased online. Among those technological developments were the emergence of the Internet in the early 1990s, and the advent of the Web in the mid-1990s (Claycomb et al., 2005). Most online transactions that involve the purchase of products and services go through the reviewing, completion, and signing of a Web-based contract (Atkins, 2003; Backhouse and Cheng, 2000). That process usually gravitates around the acceptance or rejection of Web-based contract clauses.

This paper empirically illustrates the problems associated with having individuals lacking proper training accept or reject contract clauses. It reports on an experimental study where a number of individuals without formal training in contracting issues were asked to accept or reject each of 20 clauses of a software purchasing contract. The clauses were developed based on a several sources, including existing commercial software contracts and the "Software Legal Book". The latter is a study conducted by the Society of Information Management on industry practices associated with software contracting.

Research method

The study involved 178 student subjects, of whom approximately 57 percent were males. The subjects' ages ranged from 18 to 53 years of age, with a mean of 25 years. Their work experience ranged from 0 to 35 years, with a mean of 5.6 years. Their class levels ranged from 1 to 5; the levels represented in this study were: 1 (freshman), 2 (sophomore), 3 (junior), 4 (senior), and 5 (graduate). The mean class level of the subjects was 3.3.



The subjects used a Web-based interface to accept or reject clauses. Of the 20 clauses in the contract, 6 were intentionally deceitful, in the sense that they specified binding obligations that made it unadvisable to accept them as part of a contract. Those 6 clauses were perceived as obviously deceitful by a panel of experts and professionals trained on contracting issues who were asked to review all of the clauses. From a practical perspective, correctly rejecting deceitful clauses can be seen as more critical than correctly accepting non-deceitful clauses.

The measurement model included three latent variables measured based on perceptions. These latent variables were: cognitive, or mental, effort; communication ambiguity; and dullness. Perceived cognitive effort is sometimes referred to here as COGEFF, perceived communication ambiguity as AMBIGU, and perceived dullness as DULL. Each latent variable was measured through multiple indicators. The question-statements related to each of the indicators are listed in the Appendix.

The relationship between latent variables and other variables was assessed through structural equation modeling employing that partial least squares (PLS) technique (Chin et al., 1996; Chin, 1998). The structural equation modeling analyses included two demographic variables as independent and intervening variables, namely age and work experience, respectively. The analyses also controlled for the effects of several demographic variables, namely: communication medium (text-based or video clip-based clauses shown on a Web browser), gender, scholastic aptitude (GPA), and class level (from freshman to graduate).

Results

Table 1 shows factor loadings obtained through a factor analysis. The extraction method used in the factor analysis was principal components, and the rotation method employed was varimax. Shown in shaded cells are the loadings for the indicators that were conceptually expected to load on their related latent constructs (e.g., COGEFF1 ... COGEFF4 were expected to load on COGEFF). Also shown on Table 1 are Cronbach alphas for each of the latent constructs, in the column labeled "Alpha", and the corresponding composite reliabilities, in the column labeled "CR".

Table 1: Factor loadings and alpha coefficients

	COGEFF	AMBIGU	DULL	Alpha	CR
COGEFF1	.76	.39	-.02	.82	.88
COGEFF2	.80	.35	.00		
COGEFF3	.76	.25	.15		
COGEFF4	.74	.02	.07		
AMBIGU1	.36	.76	.18	.87	.92
AMBIGU2	.19	.88	.11		
AMBIGU3	.23	.85	.18		
DULL1	.09	.13	.91	.91	.94
DULL2	.07	.14	.90		
DULL3	.03	.13	.92		

Notes:

COGEFF = cognitive, or mental, effort

AMBIGU = communication ambiguity

DULL = dullness

Alpha = Cronbach alpha coefficient

CR = composite reliability from PLS analysis

The convergent validity of a measurement model used in structural equation modeling can be assessed based on the comparison of indicator loadings expected to load on each of the respective latent constructs against a recommended threshold loading, which is generally .5 (Hair et al., 1987). For this study, the indicator loadings in question are the ones shown in the shaded cells in Table 1. They range from .74 to .92, suggesting that the measurement model presents an appropriate level of convergent validity.

Another important attribute of a measurement model is its reliability, which can be assessed through measures such as Cronbach alpha and composite reliability coefficients. As with convergent validity analysis, the determination as to whether a measurement model has good reliability hinges on the comparison of reliability measures with a recommended threshold. That threshold is generally .7 (Nunnally, 1978). As it can be seen in the columns labeled “Alpha” and “CR” of Table 1, all Cronbach alpha and composite reliability coefficients are higher than .82. This leads to the conclusion that the measurement model employed presents an appropriate level of reliability.

Table 2 shows the one-on-one correlations between the latent constructs, as well as the average variances extracted for each latent construct – the latter are shown on the diagonal, within parentheses. Also shown are the means and standard deviations for each of the constructs. The correlation coefficients shown were calculated based on Pearson’s method, and refer to bivariate rather than partial correlation estimations. All of the correlations shown are significant at the .05 level (marked with “**”) or at the .01 level (marked with “***”).

Table 2: Correlations, AVEs, means and standard deviations

	COGEFF	AMBIGU	DULL
COGEFF	(.65)		
AMBIGU	.58**	(.79)	
DULL	.17*	.32**	(.85)
Mean	4.15	4.14	3.96
SD	1.16	1.20	1.28

Notes:

Coefficients shown are Pearson correlations, and average variances extracted (diagonal)

COGEFF = cognitive, or mental, effort

AMBIGU = communication ambiguity

DULL = dullness

SD = standard deviation

** = correlation significant at the .05 level*

*** = correlation significant at the .01 level*

One final attribute that is often assessed for a measurement model based on latent constructs is the discriminant validity of the model. This attribute can be assessed based on the comparison of the correlations between the latent constructs and their individual average variances extracted (Fornell & Larcker, 1981). Here, a conservative criterion that can be used to assess discriminant validity is to check whether the average variance extracted for each latent construct is higher than any of the correlations involving the construct in question. As it can be seen from Table 2, all of the average variances extracted (shown on the diagonal) are higher than the correlations displayed below them or to their left. Therefore, it can be concluded that the measurement model presents an appropriate level of discriminant validity.

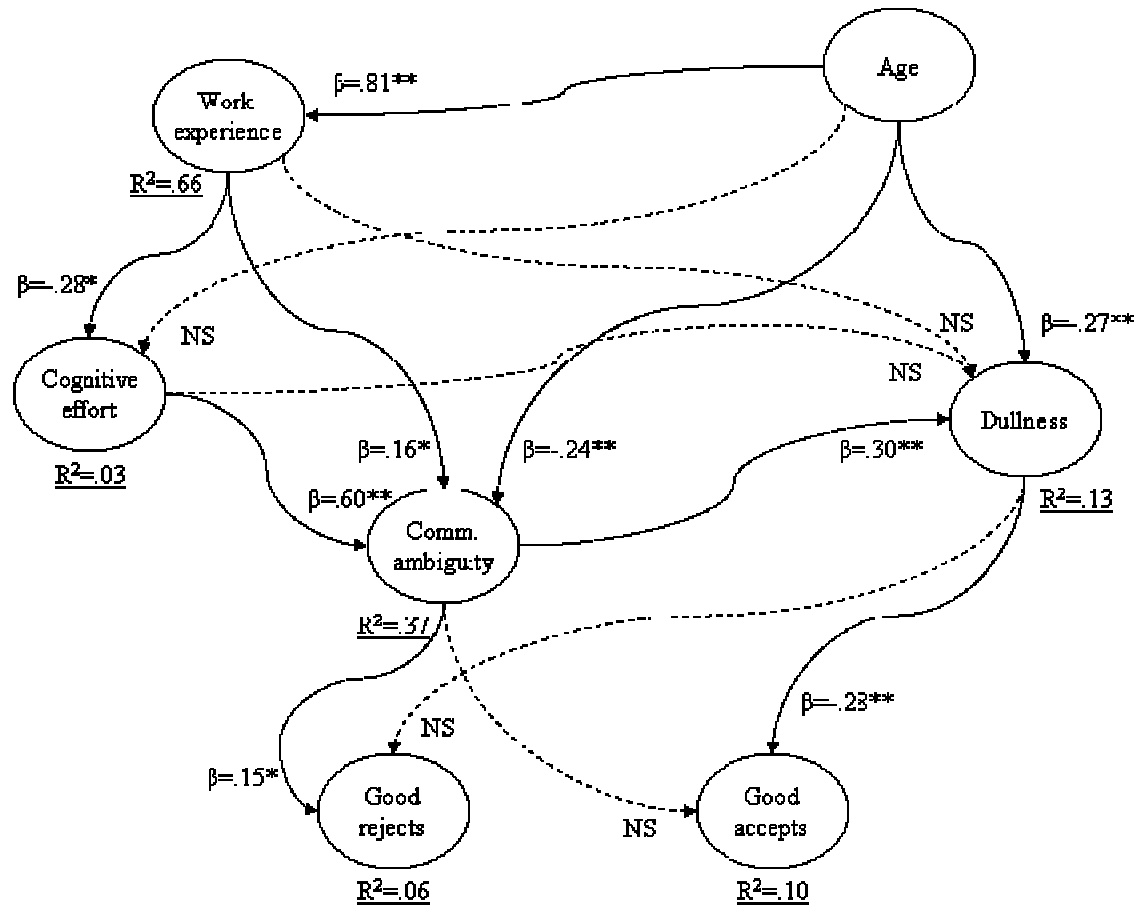
Now that it has been established that the measurement model has appropriate validity and reliability, it is possible to conduct a meaningful structural equation modeling analysis of the relationships between several of its variables. The results of one such analysis are shown in Figure 1. There, several variables are shown within ovals. Curved arrows connecting variables

depict causal relationships tested through the structural equation modeling analysis. Dotted arrows indicate relationships that are not statistically significant; full arrows indicate statistically significant ones.

The β coefficients near the full arrows in Figure 1 refer to the partial correlations associated with the significant relationships. Dotted arrows have the letters “NS” (not significant) shown instead of β coefficients. The β coefficients displayed are followed by the symbols “*” or “***”, which indicate significance levels – .05 or .01, respectively. The R^2 coefficients shown under each endogenous (i.e., dependent) variable indicate the percentage of explained variance provided by the model for that particular variable.



Figure 1: Structural equation model and estimated parameters



Notes:

Good accepts = number of non-deceitful clauses accepted

Good rejects = number of deceitful clauses rejected

β = partial correlation coefficient associated with a causal link in the model

R^2 = variance explained by the model for a particular endogenous variable

* = causal link significant at the .05 level

** = causal link significant at the .01 level

NS = causal link not significant

As it can be seen from Figure 1, age appears to have a strong relationship with work experience ($\beta = .81$, $P < .01$), which is to be expected since older individuals usually have more

work-related experience than younger ones. The relationship between age and perceived dullness was also significant, although negative ($\beta = -.27$, $P < .01$). That is, older individuals seemed to perceive the task of accepting or rejecting contract clauses as less boring than younger individuals. Age seemed to also be significantly and negatively related to perceived communication ambiguity ($\beta = -.24$, $P < .01$), which means that older individuals seemed to perceive the contract clauses as less confusing than younger individuals. Age was not significantly related to perceived cognitive effort.

Work experience appears to have a significant and negative relationship with perceived cognitive effort ($\beta = -.28$, $P < .05$), which suggests that individuals with more work experience tended to perceive the task of accepting or rejecting clauses as less complex and mentally demanding than individuals with less work experience. The relationship between work experience and perceived communication ambiguity was also significant, although positive ($\beta = .16$, $P < .05$), which means that individuals with more work experience were inclined to perceive the contract clauses as more confusing than younger individuals. Work experience was not significantly related to perceived dullness.

The degree of cognitive effort perceived by the subjects seems to have a strong and positive relationship with perceived communication ambiguity ($\beta = .60$, $P < .01$). That is, individuals who perceived the task of accepting or rejecting clauses as more complex and mentally demanding also perceived the contract clauses as more confusing. Perceived cognitive effort was not significantly related to perceived dullness.

Perceived communication ambiguity appears to be significantly related to perceived dullness ($\beta = .30$, $P < .01$), which essentially means that individuals who perceived the contract clauses as more confusing also perceived the task of accepting or rejecting contract clauses as more boring. There seemed to also be a significant relationship between perceived communication ambiguity and number of appropriate rejections of deceitful clauses ($\beta = .15$, $P < .05$), noted as “good rejects” in Figure 1. In other words, individuals who perceived the contract clauses as more confusing also did better in terms of rejecting deceitful clauses. Perceived communication ambiguity was not significantly related to the number of appropriate acceptances of non-deceitful clauses.

Perceived dullness seems to be significantly and negatively related to the number of appropriate acceptances of non-deceitful clauses ($\beta = -.28$, $P < .01$). This suggests that individuals who perceived the task of accepting or rejecting contract clauses as more boring also did worse in terms of appropriately accepting non-deceitful clauses. Perceived dullness was not significantly related to the number of appropriate rejections of deceitful clauses.

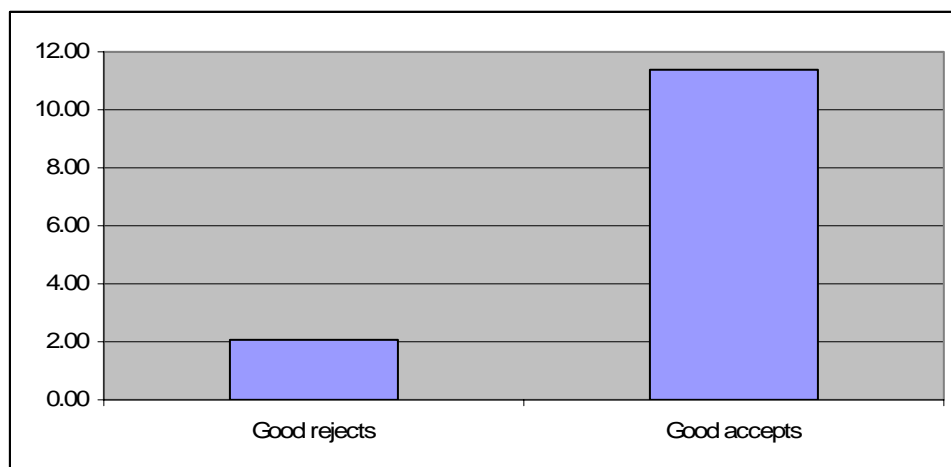
Not shown on Figure 1 are the control variables, which were included in the model as independent variables pointing at the two main dependent variables of the model – namely good rejections and acceptances. Those control variables were communication medium (text-based or video clip-based clauses shown on a Web browser), gender, scholastic aptitude (GPA), and class level (from freshman to graduate). None of those variables had a statistically significant effect on either of the two main dependent variables of the model.

Figure 2 shows a bar chart depicting the average numbers of appropriate rejections of deceitful clauses (i.e., “good rejects”), and of appropriate acceptances of non-deceitful clauses (i.e., “good accepts”). Since each clause could either be rejected or accepted, and there were 6 deceitful clauses, the average number of rejections of deceitful clauses obtained by chance would be 6 divided by 2, or 3. That is, if all individuals had accepted or rejected clauses



randomly, the average number of good rejects would be 3. Similarly, since the number of non-deceitful clauses was 14, the average number of good accepts obtained by chance would be 7.

Figure 2: Average numbers of good rejections and acceptances



Notes:

Good rejects = number of deceitful clauses rejected

Good rejects obtained by chance = 3

Good accepts = number of non-deceitful clauses accepted

Good accepts obtained by chance = 7

As it can be seen from Figure 2, the individuals participating in this study generally did worse than chance in terms of appropriately rejecting deceitful clauses, as the average number of good rejects was a little over 2 (to be more precise, it was 2.07). The standard deviation for good rejects was 1.41. Therefore, the average number of good rejects was approximately two thirds of a standard deviation lower than the number of chance good rejects; a difference large enough to be considered statistically significant given the sample size and data distribution in this study.

It can also be inferred from Figure 2 that the individuals did better than chance in terms of good accepts, or in terms of appropriately accepting non-deceitful clauses, as the average number of good accepts was a little over 11 (11.38, to be more accurate). The standard deviation for good accepts was 2.44, which means that the individuals' performance in terms of accepting non-deceitful clauses was 1.79 standard deviations above the chance performance. This is not only statistically significant, but also a relatively large difference in statistical terms.

Discussion and conclusion

On average, the subjects were able to correctly accept approximately 11 out of 14 non-deceitful clauses. Somewhat surprisingly, the subjects were able to correctly reject only about 2 out of 6 deceitful clauses. It is no exaggeration to say that a monkey trained to mindlessly accept or reject those deceitful clauses would have performed better than this study's subjects, since that monkey would have on average rejected 50 percent (or 3) of the 6 deceitful clauses. That is, on average the subjects performed worse than chance in terms of rejecting deceitful clauses.

The study also looked into the relationship between the ability to correctly accept or reject clauses and three key perceptual latent variables: cognitive (or mental) effort, communication ambiguity (or confusion), and dullness (or boredom). The degree of perceived communication ambiguity was, somewhat surprisingly, positively correlated with the ability to correctly reject deceitful clauses (perhaps because the sense of ambiguity led subjects to be more alert to deceit). The degree of perceived dullness experienced by the study subjects was negatively correlated with the ability to correctly accept non-deceitful clauses (i.e., bored individuals seemed more likely to reject acceptable clauses). Perceived cognitive effort was strongly and positively related to perceived communication ambiguity (i.e., mentally drained individuals seemed more likely to feel confused by the clauses), but not to perceived dullness.

Both demographic variables included in the model as independent and intervening variables, namely age and work experience, had statistically significant effects on other variables. The study suggests that age is negatively related to perceived communication ambiguity and dullness (i.e., older individuals experienced less confusion and boredom while going through contract clauses). It also suggests, somewhat intuitively, that work experience is negatively related to perceived cognitive effort (i.e., subjects with more work experience felt less mentally "drained" by the task). Additionally, the study suggests that age is positively related to work experience, as one would expect.

This study's findings provide the basis for a strong call for more and better training of contract officers in the DoD. Those findings also suggest that, among untrained individuals, those who are older and have more general work experience are the ones more likely to perform well in contracting tasks under conditions similar to those found in this study (i.e., Web-based contracting conditions). Finally, this study suggests exciting new avenues for research on contracting issues, particularly in connection with deceit identification in contracts. Untrained individuals seem fairly unable to identify deceit, even in cases where trained individuals would perceive it as obvious.

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